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2007-2008 YEAR BOOK

Carnegie Institution
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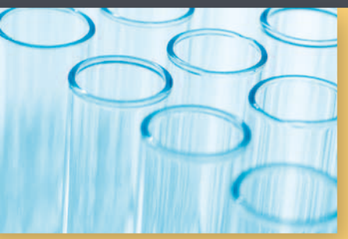
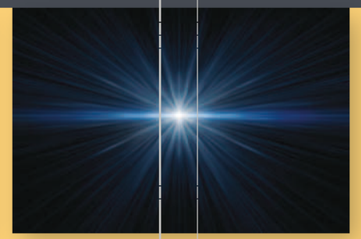
2007-2008




CARNEGIE INSTITUTION FOR SCIENCE

YEAR BOOK

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2007-2008 YEAR BOOK

The President's Report

July 1, 2007 - June 30, 2008

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". . . to encourage, in the broadest and most liberal manner, investigation, research, and discovery, and the application of knowledge to the improvement of mankind . . ."

The Carnegie Institution of Washington was incorporated with these words in 1902 by its founder, Andrew Carnegie. Since then, the institution has remained true to its mission. At six research departments across the country, the scientific staff and a constantly changing roster of students, postdoctoral fellows, and visiting investigators tackle fundamental questions on the frontiers of biology, earth sciences, and astronomy.

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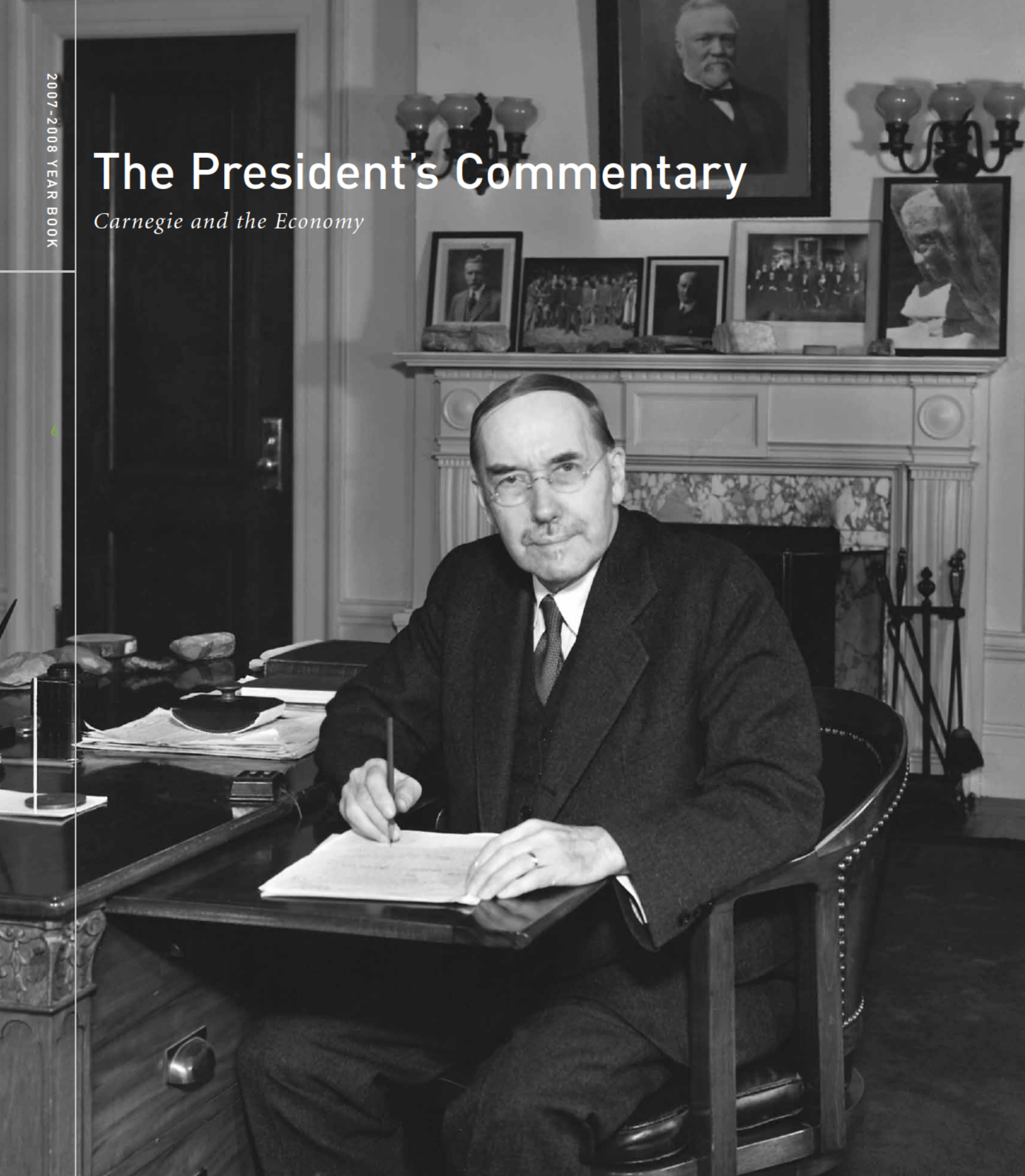


Carnegie president
Richard A. Meserve
Image courtesy Jim Johnson

John Merriam, who served as Carnegie's president from 1921 to 1938, had to make hard choices during the Great Depression.

We have all been affected by this period of unprecedented financial turbulence. I am taking this opportunity to discuss how the Carnegie Institution is impacted by these events and how, with your continued support, the institution will confront this challenging financial period.[1]

The Carnegie Institution has been in existence for over 100 years and, as I contemplated what I might write here, I took the opportunity to review the annual reports of a predecessor (John C. Merriam) who was president of the institution during the Great Depression. Merriam's most extended discussion of the subject was in his report for the fiscal year ending in October 1931.[2] He observed that one of the suggestions for responding to the "the imbalance of present day civilization" was to undertake a moratorium on research on the basis that "too much knowledge confuses us" and that "research is responsible for the maladjustment in . . . modern life." While acknowledging that new ideas "may be dangerous to society," Merriam responded that the "safety of humanity does not require a moratorium on increase in honest knowledge." Instead, he argued that "endeavor in search for truth contributes an important element of hope for the future." While acknowledging that research itself may not always by itself provide the means to meet human requirements, he nonetheless saw it as essential: "If necessity is the mother of invention, and invention is in considerable part the creative reorganization or combination of ideas and materials at hand, we must advance those types of fundamental work that produce the data which invention will use." In short, Merriam concluded that the institution's work was more important than ever.

[1] *This Year Book covers the fiscal year ending on June 30, 2008. However, because of the startling economic impacts arising after the close of the fiscal year and their significance for the institution, this overview is not limited to the fiscal year.*

[2] *J. Merriam, "Report of the President, 1931," Year Book 30/31 (Washington, D.C.: Carnegie Institution of Washington, 1931), pp. 2-7.*

Merriam's writings in subsequent years reflect a careful effort by the institution's leadership to control spending while maintaining scientific capabilities, as well as to build up emergency reserves that would provide the capacity to survive an extended period of financial challenge. Salaries were constrained and work was deferred, while always seeking to preserve the foundation for future advance. Suffice it to say, the institution weathered those troubling years successfully.

The public debate surrounding the current economic calamity has not, to my knowledge, been laid at the door of "too much knowledge." Indeed, in the economic sphere, at least, the depths of our ignorance have been revealed. Nonetheless, Merriam's basic argument about the importance of preserving our scientific capabilities has, if anything, been strengthened with the passage of time. Science not only provides the key for long-term economic advance for the reasons articulated by Merriam, but also is an essential ingredient in understanding and responding to many other challenges that demand our attention—responding to climate change, improving health care, developing clean energy sources, protecting the environment, feeding the world's growing population, preserving clean water, and diminishing the threat of terrorism and of weapons of mass destruction, among many other things.

Moreover, the strategy of financial conservatism followed by the institution in the 1930s is a useful template for today. Fortunately, we have the benefit of starting this period of economic turmoil with considerable strength. Perhaps most important, the productivity of our scientists over the last several years has been unparalleled and is recognized as such by our peers. The discussion in the subsequent pages provides a sampling of the exciting science that is under way. Publication of scientific results in the open literature is the coin of the realm in the world of basic science and, as shown by the appendix, our staff has contributed significantly to the inventory of scientific knowledge over the past year.

The following sampling of some recent awards indicates the high esteem in which our scientists are held. ›

Global Ecology director Chris Field was chosen to be part of the Intergovernmental Panel on Climate Change (IPCC) delegation to receive the 2007 Nobel Peace Prize in Oslo.
Image courtesy Nobel Foundation

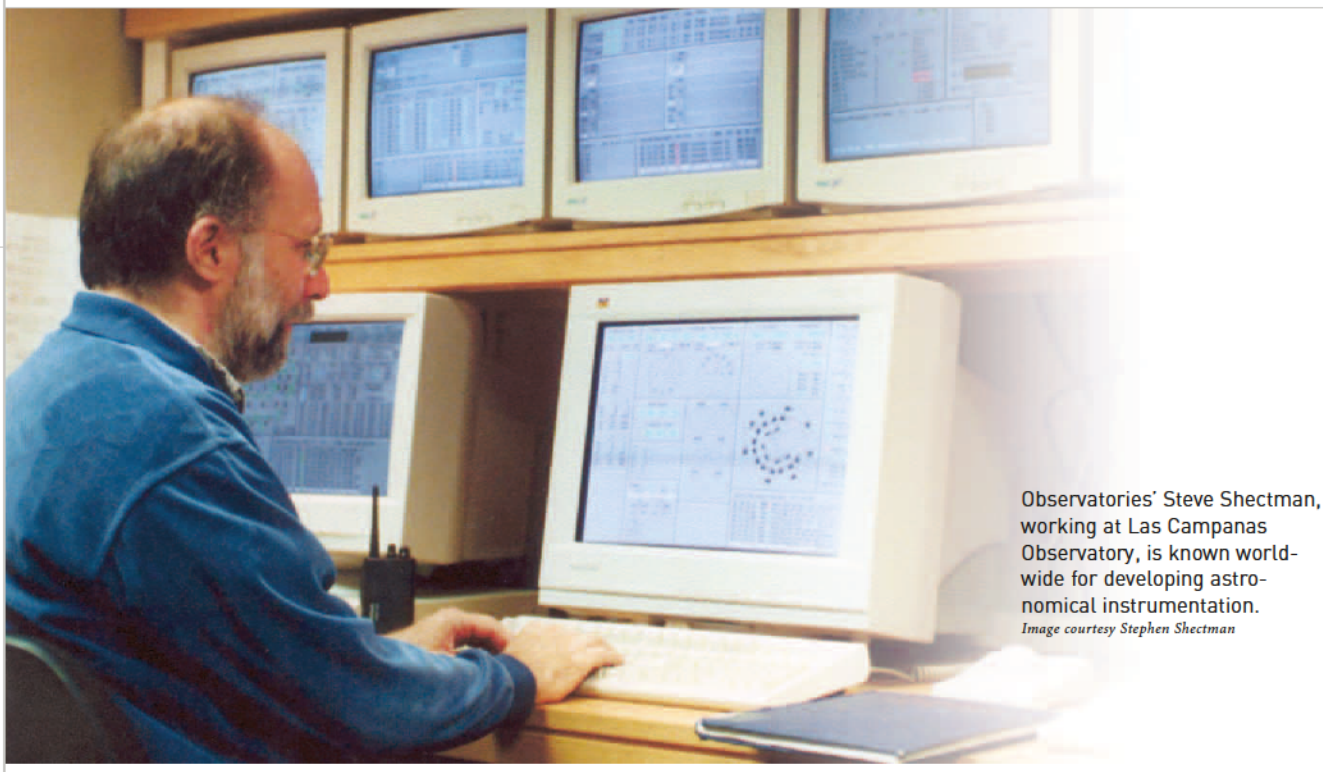
Allan Spradling, the director of the Department of Embryology, won the 2008 Genetics Prize from the Peter and Patricia Gruber Foundation in recognition of his contributions to fruit fly genomics and for "fundamental discoveries about the earliest stages of reproduction."

Chris Field, the director of the Department of Global Ecology, participated in the work of the Intergovernmental Panel on Climate Change (IPCC) and was invited to represent the United States at the award of the Nobel Peace Prize to the IPCC.

Ho-kwang (Dave) Mao of the Geophysical Laboratory was elected a Foreign Member of the Royal Society of London for his "extraordinary creative impact" in high-pressure science and related technology development for over 40 years. He also won the 2007 Inge Lehmann Medal from the American Geophysical Union for his "outstanding contributions to the understanding of the structure, composition, and dynamics of the Earth's mantle and core."

Bjørn Mysen of the Geophysical Laboratory was elected a fellow by the Geochemical Society and the European Association for Geochemistry. The title is "bestowed upon outstanding scientists who have, over some years, made a major contribution to the field of geochemistry."

The Geophysical Laboratory's Dave Mao signs the charter book at his induction into the Royal Society of London.
Image courtesy Royal Society of London



Observatories' Steve Shectman, working at Las Campanas Observatory, is known worldwide for developing astronomical instrumentation.
Image courtesy Stephen Shectman

An icon in astronomy, Terrestrial Magnetism's Vera Rubin has received numerous awards over the years for her groundbreaking work and public service.

Stephen Shectman of the Carnegie Observatories received the Jackson-Gwilt Medal from the Royal Astronomical Society for his exceptional work in developing astronomical instrumentation and in constructing telescopes.

Vera Rubin of the Department of Terrestrial Magnetism received the 2008 Richtmyer Memorial Award from the American Association of Physics Teachers for her "outstanding contributions to physics and effectively communicating those contributions to physics educators," and the Cosmos Club Award, granted to people "of national or international standing in a field of science, literature, the fine arts, the learned professions, or the public service."

Winslow Briggs of the Department of Plant Biology won the 2007 Adolph E. Gude, Jr. Award established by the American Society of Plant Biologists for his outstanding service to the science of plant biology.

Ronald Cohen of the Geophysical Laboratory received the 2009 Dana Medal of the Mineralogical Society of America. The medal recognizes individuals in the middle of their career for continued outstanding scientific contributions in the mineralogical sciences through original research.

Global Ecology's Greg Asner, shown here in the cockpit of the Carnegie Airborne Observatory, is a pioneer in the remote mapping of rain forest species.
Image courtesy Greg Asner

Greg Asner of the Department of Global Ecology was selected by *Popular Science* as one of 2007's "Brilliant Ten" for creating new ways "to map the environment and everything in it."

Russell Hemley, the director of the Geophysical Laboratory, was elected to Corresponding Fellowship of the Royal Society of Edinburgh. The society was created in 1783 for "the advancement of learning and useful knowledge." Members are elected by the fellows and come from the sciences, arts, humanities, industry, and commerce.

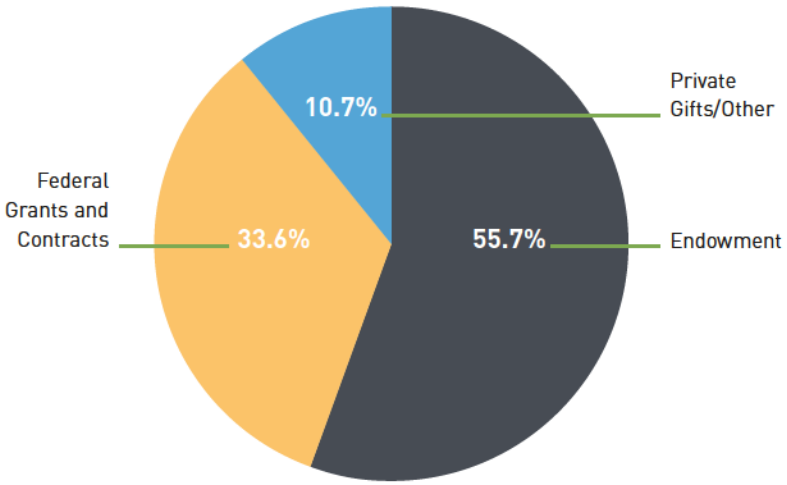
Joseph Gall of the Department of Embryology shared the 2007 Louisa Gross Horwitz Prize, awarded by Columbia University. The award honors his work on telomeres—structures that protect the ends of chromosomes during DNA replication.

Mark Phillips of the Carnegie Observatories shared the 2007 Cosmology Prize of the Peter and Patricia Gruber Foundation for his role in discovering that the universe is expanding at an accelerating rate.

The Carnegie staff's demonstrated capacity to produce outstanding science provides the foundation that will enable us to weather the current storm.

In addition to his award-winning research on supernovae, Mark Phillips is the associate director of the Las Campanas Observatory.

Figure 1. 2008-2009 Budget by Revenue Source

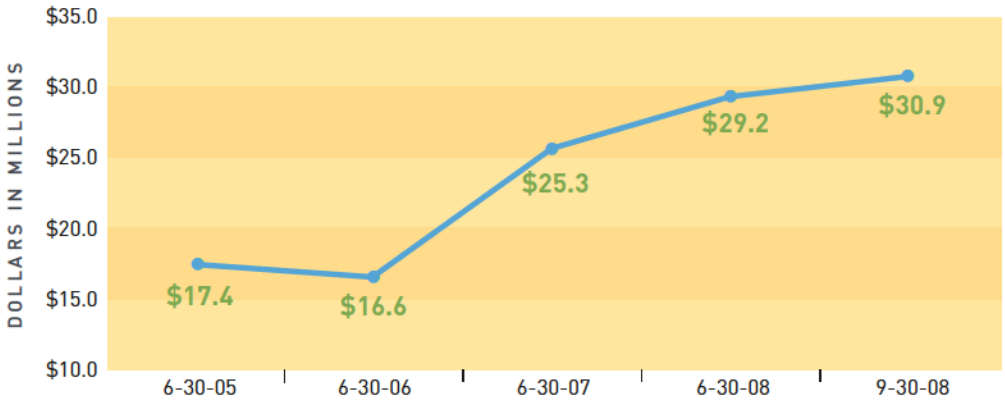


Nonetheless, we will feel adverse effects from the economic meltdown. Our principal sources of revenue are support from the endowment, federal grants and contracts, and private support by foundations and individuals. The percentage contribution of each to our budget is shown in Figure 1. We find that each source of funds is threatened.

As discussed in previous Year Books, Carnegie has greatly benefited from the diligent stewardship of our endowment by our Finance Committee. At the end of fiscal year 2008, our endowment had reached a value of more than $870 million, an increase of 65% over the previous five years. We achieved this remarkable growth through the disciplined allocation of the endowment to diverse investments and through the careful selection of managers. But the financial downturn has affected investments of all types, with the result that our investment diversity did not protect us from significant deterioration in valuations. At December 31, 2008, our endowment valuation had fallen to approximately $650 million, a decline of 25 percent. It is little solace that we have not suffered losses to the same extent as many other institutions. The decline in the endowment undercuts our principal source of budgetary support.

Fortunately, our inventory of federal grants and contracts has expanded over the past year. As shown in Figure 2, our inventory of unexpended federal grants and contracts has grown from $17.4 million at June 30, 2005, to $30.9 million at September 30, 2008. This increased support is a testament to the recognized skill and capability of our staff.

Figure 2. Unexpended Federal Grants and Contracts



Because these grants typically extend over several years, we do not anticipate that federal revenues will decline significantly over the fiscal year ending in June 2010. But it is clear that the demands on the federal budget are growing at a time of reduced receipts, no doubt creating great pressures on the discretionary parts of the federal budget in the years ahead. The new administration has indicated its intent to increase federal support for science. This is wise because scientific research provides the basis for productivity gains (among many other things), and it would be foolish to sacrifice the long-term economic benefits that science can yield to meet short-term objectives. Nonetheless, it is clear that the government may find it difficult to provide significant new funds for science over the next few years given the country's many other pressing challenges. Hence, Carnegie must prepare for the possibility that federal research support may decline in the coming period.

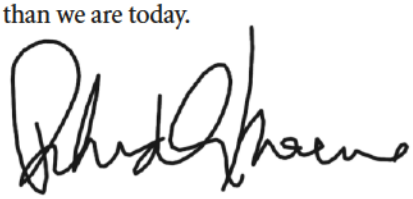
Our support from private foundations and individuals is also important. Grants have been received from many major foundations that have enabled us to launch important new initiatives. The support for the Carnegie Airborne Observatory (CAO), for example, opens new ways to conduct ecological assessments over wide areas, providing a tool of great importance in measuring the impacts of climate change and the pressures on land use. This fact was recognized early by Carnegie trustee Will Hearst, who provided early support for the CAO, and the project has garnered significant support from the Keck, MacArthur, Mellon, and Moore foundations. Similarly, the sustained and generous support from individuals who understand the value of Carnegie's work is a gratifying and extremely valuable development. But, of course, both foundations and individuals are

affected by the economic downturn. We thus recognize that their continuing generosity may be difficult to sustain over the next several years and that we must plan accordingly.

In short, we go into this difficult period with noteworthy scientific and financial strength, but we must anticipate that we may see reductions in all our sources of funding in the next few years. We will benefit in this context from a continuation and expansion of our disciplined approach to the management of our resources. Our ratio of outstanding debt to assets is the envy of many of our peers. We have obtained savings in administrative costs, such as health-care and other insurance, and are increasing revenue from the rental of our P Street headquarters. Our overall administrative efficiency is demonstrated by the fact that Charity Navigator, America's largest evaluator of nonprofits and charities, has awarded Carnegie its highest rating, four stars, for sound fiscal management for eight years running; we are one of only four organizations that have achieved this status out of some 5,300 entities that are monitored. But the great progress that we have made in efficiency will have to be enhanced.

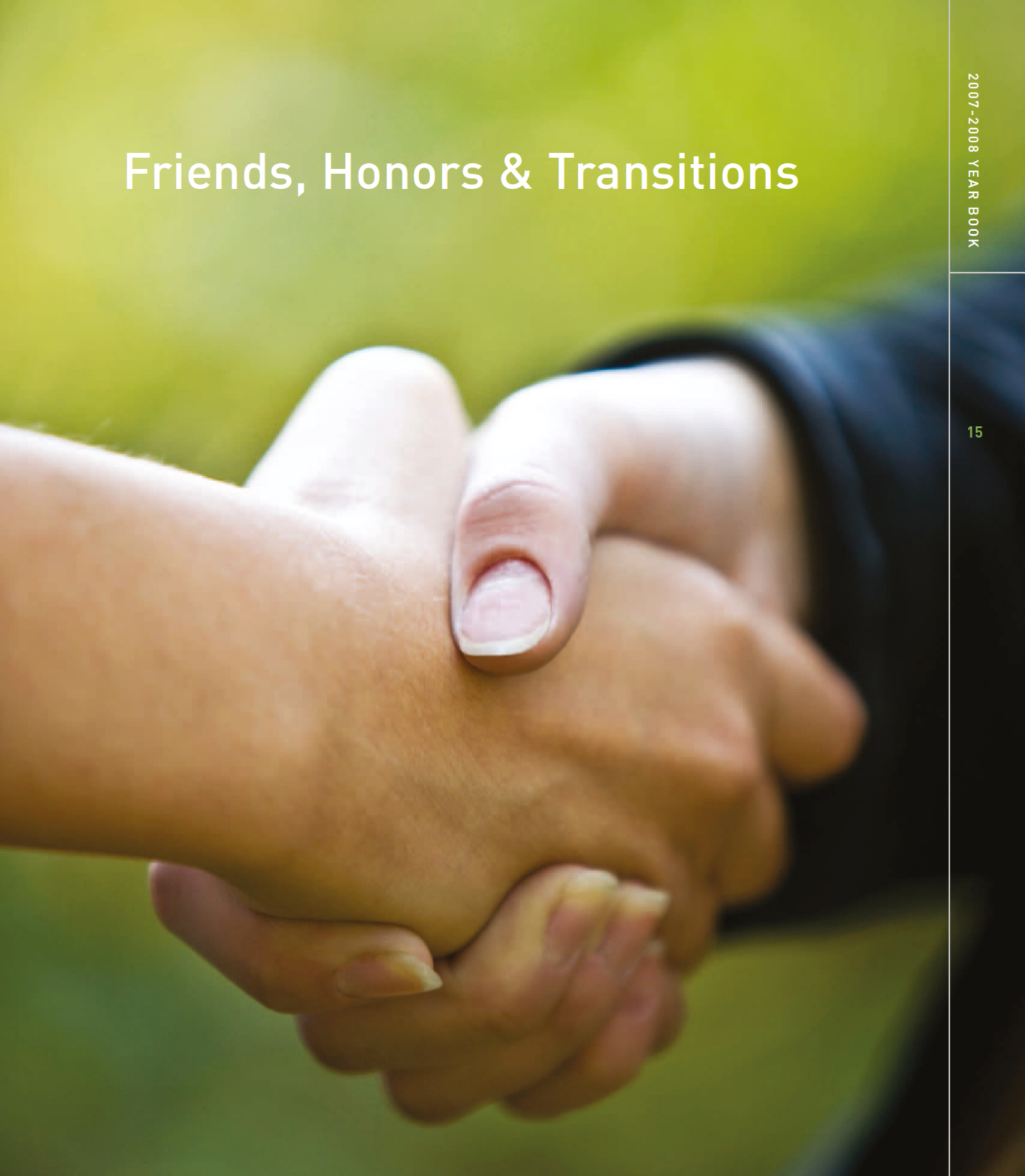
At the same time, we are planning to adjust our endowment spending so as to smooth budgetary impacts. The anticipated decline in endowment returns in this fiscal year will not result in a proportionate reduction of available spending, thereby avoiding a radical disruption of important ongoing projects. But we confront a real need to manage resources carefully during this period, and our budgets for several years will need to be constrained until the economy turns around. I have asked Carnegie's department directors to plan for this reality, and I know that I have their support.

The experts anticipate that resolving the current difficulties in the financial markets will take some time. But, as we look to the future, we will continue to benefit from the expertise and engagement of our board of trustees. We will maintain and will benefit in the long term from our highly diversified portfolio. We remain hopeful that the many individuals and institutions that have assisted us in the past will continue to help in these difficult times. With care in husbanding our funds, I am confident that we will weather this storm as we weathered the 1930s. The Carnegie Institution will continue to do outstanding science, and we will emerge from this period even stronger than we are today.



Richard A. Meserve

Friends, Honors & Transitions



Carnegie Friends

Annual Giving

The Barbara McClintock Society

An icon of Carnegie science, Barbara McClintock was a Carnegie plant biologist from 1943 until her retirement. She was a giant in the field of maize genetics and received the 1983 Nobel Prize in Physiology/Medicine for her work on patterns of genetic inheritance. She was the first woman to win an unshared Nobel Prize in this category. To sustain researchers like McClintock, annual contributions to the Carnegie Institution are essential. The McClintock Society thus recognizes generous individuals who contribute $10,000 or more in a fiscal year, making it possible to pursue the highly original research for which Carnegie is known.

$100,000 to $999,999

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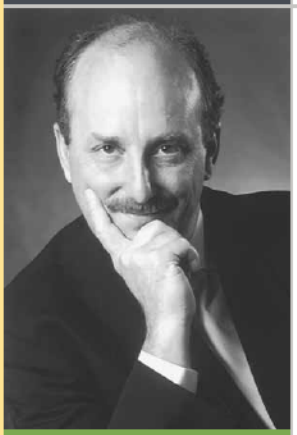
William R. Hearst III



Carnegie trustee William R. Hearst III always had his eyes on the future. When named editor and publisher of the Pulitzer Prize-winning *San Francisco Examiner* in 1984, he set out to revolutionize a newspaper acquired by his grandfather a century earlier. After leaving his mark on the *Examiner*, Hearst focused on the digital future. He served as director of many high-tech companies, including Sun Microsystems, and joined Silicon Valley's venture capital firm Kleiner Perkins Caufield & Byers.

Hearst has always had a passion for science and math. He graduated from Harvard with a degree in mathematics in 1972 and later became active in the Astronomical Society of the Pacific. There he learned about the Carnegie Institution from Nobel Prize-winning physicist and Carnegie trustee Charles Townes. After his first meeting with Carnegie trustees and scientists, he realized that he could watch science in the making. It was a perfect match. Carnegie's board elected him a trustee in 1992.

Over the years, Hearst has introduced many prominent Californians to Carnegie science by hosting events in his hometown of San Francisco. He organized a trustee dinner and lecture on astronomy at the San Francisco Planetarium in 1993 and a trustee dinner at the San Francisco Exploratorium in 1996. A member of the Edwin Hubble Society, he more recently provided several major gifts to Carnegie, including seed funding for the Carnegie Airborne Observatory at the Department of Global Ecology.

As a trustee of the private foundation established by his grandfather in 1945, Hearst helped to secure the initial funding to endow Carnegie's K-12 science education programs. For over 16 years, Carnegie has benefited from Hearst's enormous generosity and insight. The institution thanks him for his help and for serving as one of its important links between the West and East Coasts.

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Frederick P. Woodson

Under $1,000

Judith C. Adams
Jagannadham Akella
Sheldon Applegate
Joseph P. Ardizzi
Robert Armstrong
Louis G. Arnold
Lawrence C. Baldwin
Alain Baronnet
Richard S. Barr
Manuel N. Bass
Clifton J. Batson
Harvey E. Belkin
Peter M. Bell
Devora M. Bennett
Jack Bennett
John W. Bergstrom
Leslie C. Berlowitz
Giuseppe Bertani
Beverlee Bickmore
Eoban Binder
Morris and Madeleine Birnbaum
Lloyd Biscomb
William Blanpied
Kurt R. Borski
Randolph Boyle
Robin Brett
Winslow R. Briggs
Peter C. Brockett
Kenneth Brockman
Harold Brodsky and Naomi Brodsky

**Deceased*

Jeanette S. Brown
Philip S. Brown
Robert and Jennifer Brown
David and Rosemary Buden
Allan B. Burdick
Marjorie Burger
James R. Burke
Gordon Burley
Donald M. Burt
Robert Cadmus
Christopher Cahill
John A. Caldwell
Allan Campbell
Finley A. Campbell
Carol L. Carpenter
Timothy J. Carr
Dana Carroll
Liang-Chen Chen
Wen P. Chen
Asit Choudhuri
Ida Chow
Mary Coder
Michael P. Cohen
Lauren and Cathy Colloff
John D. Cooper
Katherine Cooper
Jonathan Coopersmith
Elliott D. Corn
José M. Correia Neves
Ronald Croasdale
John R. Cronin
Daniel L. Crotty
Martin Czigler
Howard H. Dana
Edward E. David
John E. Davis
Nicholas F. Davis
Ruth Day
Charles T. De Vault
John B. Denniston
R. P. Detwiler
David H. DeVorkin
Robert C. DeVries
Richard V. Dietrich
John F. Dilley
Henry DiMond
John B. Doak
Sandro D'Odorico
Bruce R. Doe
David Driggs
James Drummond
Arnost Dudek
Reginald B. Elliott
John Farhood
Brian Farrell
Frederick M. Feldheim
Raul Fernandez
Dorothy R. Fischer
Marilyn Fogel
Frederick Forro
Christine Foster
John Fournelle
Richard K. Fox
James N. Franke
Lafayette Frederick
Laurence W. Fredrick
Bonnie Freeman
William L. Friend
Fred S. Fry
Gladys H. Fuller
Joseph H. Gainer
Esra Galun
David Gambrel
Joan Gantz
Stephen Gao
Domenico Gellera
M. C. Gilbert
James F. Goff
Mary Helen M. Goldsmith
David J. Goldston
Barbara Graves
Thomas and Josephine Greeley
Frederick Greenewalt
Irene M. Grill
Philip M. Grimley
John J. Gurney
Marianne U. Gustafson
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Patricia E. Hare
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Stanley R. Hart
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Karl M. Hartmann
Gordon S. Hawkins
Ulrich Heber
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Norris C. Hekimian
H. L. Helfer
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Mary Hoyer
Larry D. Huffman
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John H. Jacobs
Richard Jacobson
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Lucy Latane Jeffers
Beverly J. Johnson
Theodore J. Johnson
Kathleen E. Jolly
Eddie D. Jordan
Hiroaki Kagawa
Sarah Kaiser
Peter G. Katona
Julie Katzman
James P. Kelly
Charles Kengla
Susan D. Kern
Ed Kiessling
Ken and Gwendolyn Kiessling
Marguerite J. Kingston
Thomas and Mary Kirby
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Charles E. Kohlhase
William E. Kopka
Olavi Kouvo
Albert R. Kranz
Audrey S. Krause
Jeffrey L. Kretsch
Ikuo Kushiro
Anthony Lake
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Arthur and Faith LaVelle
Samuel A. Lawrence
Harold H. Lee
Bill G. Leflang
Ernest H. Lehmann
Lavonne Lela
Frederick K. Lepple
Alan E. Levin
Sharon Levy
F. H. Lewis
Kathleen D. Lewis
Steven and Nancy L'Hernault
Martin G. Lichtenstein
Jeanine Linossi
Kelly H. Liu
Felix J. Lockman
Patricia H. Lonardo
Peter B. Lyons
Raymond E. Mabus
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Steven R. Majewski
Michael E. Malone
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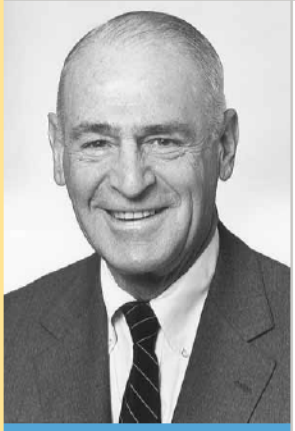
Dennis McCormick
Sheila McCormick
Sean McCruhon
Susan G. McIlwain
David McMeans
Neil R. McNamara
Timothy P. Mertz
Ronald Metzger
Dennis F. Miller
Lee J. Miller
Lowell and Ruth Minor
Joseph F. Moore
Robert L. Morris
Mary Lee Morrison
John Morrow
David J. Mossman
Gary G. Mrenak
Thomas A. Mueller
Charles G. Myers
Ralph H. Nafziger
Yoshitsugu Nakagawa
Michael Nemesure
Norman and Georgine Neureiter
Phillip and Sonia Newmark
Richard L. Nielsen
Peter J. Nind
Adrianne Noe
Noboru Oba
Michael O'Connor

Sidney J. Weinberg, Jr.



As a Goldman Sachs partner beginning in the mid-1960s, Sidney J. Weinberg, Jr., was not just interested in the financial world; he also wanted to advance scientific research and education. In 1965 he became a trustee for the Carnegie Foundation for the Advancement of Teaching. There he met the late Bill Greenough, a Carnegie Institution trustee at the time, who introduced Weinberg to the world of Carnegie science.

Weinberg was inspired by Andrew Carnegie's vision of giving exceptional scientists—individual investigators—the independence to pursue their passions. He became hooked on Carnegie science and was elected to the board in 1983. He served as a member of the Finance Committee before becoming its chairman in 1984, a position he held through the late 1980s. He was a member of the Employee Benefits Committee and became chairman of the Nominating Committee in 1993. In that role he was indispensable in introducing Carnegie to a broader mix of impressive individuals. Weinberg became a senior trustee in 1999, but has continued to participate actively in board meetings. His peers continue to marvel at his ability to listen to a discussion, then directly put his finger on the heart of the matter.

The 1980s was an era of great change at the institution. In late 1984 Weinberg served on the committee that examined the co-location of the Geophysical Laboratory with the Department of Terrestrial Magnetism. Through his work on the Magellan Campaign Committee and the Observatories Visiting Committee, he helped the institution navigate the challenging issues associated with the construction of the Magellan twin 6.5-meter telescopes at the Las Campanas Observatory in Chile.

Weinberg has been exceptionally generous to the institution over the last 25 years, with major gifts to every Carnegie campaign. He is a member of the Edwin Hubble Society. His wisdom, guidance, and commitment to Carnegie's mission have been unparalleled, and the institution is sincerely grateful for his decades of dedication.

Goetz K. Oertel
Michael Ollinger
Gilbert S. Omenn
John G. Ormerod
R. B. Parry
Arnold Phifer
Gregory F. Pilcher
Elizabeth A. Piotrowski
John E. Porter
Daniel W. Pugh
Shirley Raps
Donald G. Rea
Minocher Reporter
Philippe Reymond
Dan Rice
Benjamin Richter
James and Ann Riley
Lindsey C. Robertson
Emory L. Robotham
Richard L. Rotundo
Nadia M. Saad
Rachel Safer
Akira Sasaki
James B. Saukel
Herb Schulsinger
Joyce R. Schwartz
François and Linda Schweizer
Malcolm Scully
Martin G. Seitz
Constantine E. Sekeris
Nobumichi Shimizu
Walter Shropshire
Randolph Sim
Mary E. Simon
Virginia B. Sisson
Christine D. Smith
David E. Snead
David L. Soderberg
Erich W. Steiner
Alan M. Stueber
Kathleen Taimi
Gary R. Tanigawa
Lawrence A. Taylor
Mack Taylor
Thomas M. Tekach
James R. Thomas
Mira Thompson
Norbert Thonnard
Tom Thornbury
Peter A. Tinsley
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Jonathan Tuerk
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William B. Upholt
W. K. VanNewkirk
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David Velinsky
Richard J. Walker
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Johannes Weertman
Gordon Weil
Roberta M. Weil
Philip Wenger
Edward White
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Frank K. Wyatt
Kenzo Yagi
Robert Yamartino
Charles Yanofsky
Robert A. Young
Violet K. Young
Shu-cheng Yu
Timothy A. Zimmerlin
Wanna Zinsmaster

Foundations and Corporations

Over $1 Million

W. M. Keck Foundation
John D. and Catherine T. MacArthur Foundation
Gordon and Betty Moore Foundation

$100,000 to $999,999

The Gayden Family Foundation
Math for America, Inc.
Andrew W. Mellon Foundation
Ambrose Monell Foundation
Alfred P. Sloan Foundation

$10,000 to $99,999

Anonymous (1)
Michael and Eugenia Brin Philanthropic Fund
The Brinson Foundation
Carnegie Inst. of Canada/Institution Carnegie du Canada
O. P. and W. E. Edwards Foundation
Fannie Mae Foundation
Herman Frasch Foundation for Chemical Research
Golden Family Foundation
Richard W. Higgins Foundation
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Linden Family Fund
Richard Lounsbery Foundation, Inc.
The McMurtry Family Foundation
The Robert & Bethany Millard Charitable Foundation
The Ralph M. Parsons Foundation
Pearle Vision Foundation
The Rose Hills Foundation
M & C Stone Charitable Trust
The Weathertop Foundation
The Sidney J. Weinberg, Jr. Foundation

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The Abell Foundation
Agassiz Road Nominee Trust
The Bristol-Myers Squibb Foundation, Inc.
Cavalieri-Look Fund
Damel Investors LLC
The Thomas W. Dower Foundation
Ernst Charities
Michael E. Gellert Trust
Hawthorne Fund
Margaret and William R. Hearst III Gift Fund
The Holaday Foundation
Inman Foundation
Samuel H. Kress Foundation
Laubach Family Fund
Lubin Family Foundation
Lutron Foundation
Robert W. and Gladys S. Meserve Charitable Trust
Millmark Education Corporation
Mulago Foundation
The New York Community Trust
Pfizer Foundation Matching Gifts Program
Roxiticus Fund
Zimmer Gunsul Frasca Architects LLP

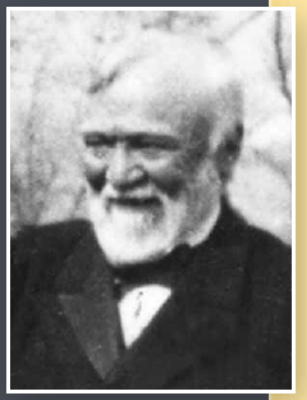
Government

Over $1 Million

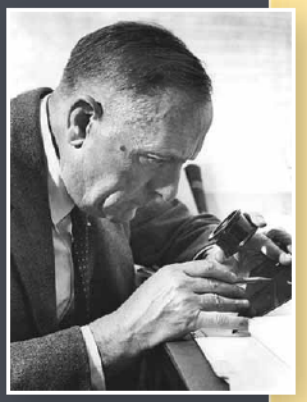
National Aeronautics and Space Administration
National Science Foundation
Space Telescope Science Institute
U.S. Department of Energy
U.S. Public Health Service

$100,000 to $1 Million

USDA Forest Service
U.S. Office of Naval Research



★ *Andrew Carnegie*



★ *Edwin Hubble*

★ *Vannevar Bush*

Lifetime Giving Societies

The Carnegie Founders Society

Andrew Carnegie, the founder of the Carnegie Institution, established it with a gift of $10 million. Although he ultimately gave a total of $22 million to the institution, his initial $10 million gift represents a special level of giving. In acknowledgment of the significance of this initial contribution, individuals who support Carnegie's scientific mission with lifetime contributions of $10 million or more are recognized as members of the Carnegie Founders Society.

Caryl P. Haskins*
William R. Hewlett*

The Edwin Hubble Society

The most famous astronomer of the 20th century, Edwin Hubble, joined the Carnegie Institution in 1919. Hubble's observations shattered our old concept of the universe. He proved that the universe is made of collections of galaxies and is not just limited to our own Milky Way—and that it is expanding. This work redefined the science of cosmology. Science typically requires years of work before major discoveries like these can be made. The Edwin Hubble Society honors those whose lifetime support has enabled the institution to continue fostering such long-term, paradigm-changing research by recognizing those who have contributed between $1,000,000 and $9,999,999.

D. Euan and Angelica Baird
Michael and Mary Gellert
Robert G. and Alexandra C. Goelet
William T. Golden*
William R. Hearst III
Richard E. Heckert
Kazuo and Asako Inamori
Burton and Deedee McMurtry
Jaylee and Gilbert* Mead
Cary Queen
Deborah Rose, Ph.D.
Thomas and Mary Urban
Sidney J. Weinberg, Jr.

The Vannevar Bush Society

Vannevar Bush, the renowned leader of American scientific research of his time, served as Carnegie's president from 1939 to 1955. Bush believed in the power of private organizations and wrote in 1950, "It was Andrew Carnegie's conviction that an institution which sought out the unusual scientist, and rendered it possible for him to create to the utmost, would be worth while [sic] . . ." He further said that "the scientists of the institution . . . seek to extend the horizons of man's knowledge of his environment and of himself, in the conviction that it is good for man to know." The Vannevar Bush Society recognizes individuals who have made lifetime contributions of between $100,000 and $999,999.

Anonymous (3)
Bruce and Betty Alberts
Daniel Belin and Kate Ganz
Didier and Brigitte Berthelemot
Donald and Linda Brown
A. James Clark
Tom and Anne Cori
Jean and Leslie Douglas
Bruce Ferguson and Heather Sandiford
Stephen and Janelle Fodor
William and Cynthia Gayden
Robert and Margaret Hazen
Antonia Ax:son Johnson and Goran Ennerfelt
Gerald and Doris* Laubach
John D. Macomber
Steven L. McKnight
Richard A. and Martha R. Meserve
Al and Honey Nashman
Evelyn Stefansson Nef
Vera and Robert* Rubin
William J. Rutter
Allan Sandage
Christopher and Margaret Stone
William and Nancy Turner

Second Century Society

The Carnegie Institution is now in its second century of supporting scientific research and discovery. The Second Century Society recognizes individuals who have remembered, or intend to remember, the Carnegie Institution in their estate plans and those who have supported the institution through other forms of planned giving.

Bradley F. Bennett
Eleanora Dalton
Nina V. Fedoroff
Marilyn Fogel and Chris Swarth
Kirsten H. Gildersleeve
William T. Golden*
Robert and Margaret Hazen
Paul and Carolyn Kokulis
Gilbert and Karen Levin
Evelyn Stefansson Nef
Allan Sandage
Leonard Searle
Maxine and Daniel Singer
Hatim A. Tyabji

**Deceased*

Members were qualified with gift records we believe to be accurate. If there are any questions, please call Mira Thompson at 202.939.1122.

Honors & Transitions

Honors

Administration

Senior trustee **David Swensen**, chief investment officer at Yale University, was elected to the American Academy of Arts and Sciences in spring 2008.

Embryology

Staff member **Joseph Gall** delivered the opening lecture and received the 2007 Wilhelm Bernhard Medal at the 20th Wilhelm Bernhard Workshop: International Conference on the Cell Nucleus, in St. Andrews, Scotland, in August 2007, and he shared the 2007 Horwitz Prize.

Director **Allan Spradling** was awarded the 2008 Gruber Genetics Prize in recognition of his contributions to fruit fly genomics and for "fundamental discoveries about the earliest stages of reproduction."

Geophysical Laboratory

The Geological Society of America announced in October 2007 that **Ronald Cohen** would receive the 2009 Dana Medal of the Mineralogical Society of America. The Dana Medal "is intended to recognize continued outstanding scientific contributions through original research in the mineralogical sciences by an individual in the midst of their career."

Electronics engineer **Christos Hadidiacos** was selected as the first recipient of the Carnegie Institution's new Service to Science Award. This award was created in 2007 to recognize outstanding and/or unique contributions to science by employees who work in administrative, support, and technical positions. Hadidiacos has made invaluable contributions over a 42-year career, beginning with the arrival of the first electron microprobe at the Geophysical Lab.

In March 2008 Director **Russell Hemley** was elected to Corresponding Fellowship of the Royal Society of Edinburgh—Scotland's national academy of science and letters.

In May 2008 **Ho-kwang (Dave) Mao** was elected a Foreign Member of the Royal Society of London, the national academy of science of the United Kingdom, for his "extraordinary creative impact" in high-pressure science and related technology development for over 40 years.

Senior scientist **Bjørn Mysen** was named a Geochemical Fellow for 2008 by the Geochemical Society and the European Association for Geochemistry.

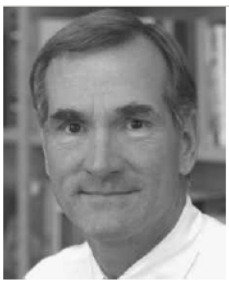
Global Ecology

Staff scientist **Greg Asner** was picked by *Popular Science* magazine as one of the 10 most brilliant young scientists in the country in 2007.

Staff scientist **Ken Caldeira** and director **Chris Field** were key contributors in the UN panel awarded the 2007 Nobel Peace Prize in October for work on global climate change. The Intergovernmental Panel on Climate Change shares the prize with former vice president Al Gore for his role in communicating the issue to the public. Field was one of 25 researchers chosen to attend the Nobel Peace Prize ceremony and banquet in December in Oslo, Norway.

Observatories

The Royal Astronomical Society awarded **Stephen Shectman** the 2008 Jackson-Gwilt Medal for his exceptional work in developing astronomical instrumentation and in constructing telescopes. **Mark Phillips** shared the 2007 Cosmology Prize of the Peter and Patricia Gruber Foundation.



★ *David Swensen*

★ *Joseph Gall*

★ *Allan Spradling*

★ *Ronald Cohen*

★ *Christos Hadidiacos*

★ *Russell Hemley*

★ *Ho-kwang (Dave) Mao*

★ *Bjørn Mysen*

★ *Greg Asner*

★ *Ken Caldeira*

★ *Chris Field*

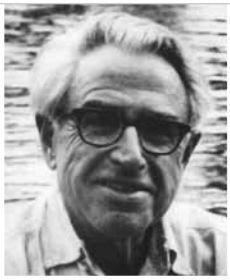
★ *Stephen Shectman*

★ *Mark Phillips*

★ *Chris Somerville*

★ *Winslow Briggs*

★ *Vera Rubin*



★ *William T. Golden*

★ *Robert C. Seamans, Jr.*

★ *Wolf Frommer*

★ *Christine Smith*

★ *Alex Schreiber*

★ *Scott Sheppard*

Plant Biology

Former department director **Chris Somerville** was awarded an honorary doctorate by the University of Guelph and was named a fellow of the American Society of Plant Biologists. In October 2007 Somerville, with Jay Keasling, received BayBio's Visionary Award for bringing bioenergy research institutes to the region. **Winslow Briggs** received the 2007 Adolph E. Gude, Jr. award from the American Society of Plant Biologists.

Terrestrial Magnetism

Astrophysicist **Vera Rubin** received the 2008 Richtmyer Memorial from the American Association of Physics Teachers at their 2008 winter meeting in Baltimore. In March she received the 2008 Cosmos Club Award in Washington, D.C.

Transitions

Senior trustee **William T. Golden** died on October 7, 2007, at the age of 97.

Trustee emeritus **Robert C. Seamans, Jr.**, died on June 28, 2008, at the age of 89.

On December 1, 2007, **Chris Somerville**, director of Plant Biology since 1994, became the first director of the Energy Biosciences Institute (EBI)—a new research and development organization with an interdisciplinary approach to solving global energy needs and reducing fossil-fuel emissions that contribute to global warming. Staff member **Wolf Frommer,** at Carnegie since 2003, became the acting director of the department.

Chief Advancement Officer **Christine Smith** left Carnegie May 23 to become associate vice president for advancement at Lehigh University in Bethlehem, Pennsylvania.

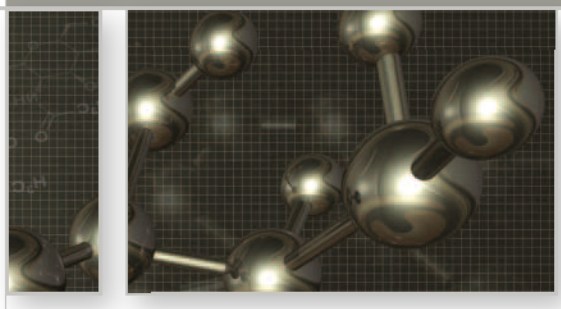
Embryology staff associate **Alex Schreiber** took a position at the College of Notre Dame of Maryland.

Former Hubble Fellow at Terrestrial Magnetism **Scott Sheppard** joined the research staff in July 2007.

Research Highlights

Embryology

Deciphering the Complexity of Cellular, Developmental, and Genetic Biology



What Controls the Genetic Shuffle?

Ever wonder why your niece looks more like you than either of her parents? It's because nature shuffles genes to ensure a diverse population. This genetic scrambling, called recombination, is vitally important, but little is known about what controls it. Using the nematode *C. elegans,* Judith Yanowitz has found that the organization of chromatin, the complex of material that includes DNA, RNA, and protein and makes up chromosomes, is fundamental to regulating recombination. She is also investigating how environmental factors and age alter recombination.

Recombination occurs during a two-part cell division process known as meiosis that forms egg and sperm. During meiosis the chromosomes pair up inside the cells, "cross over" each other, and swap similar genes. When egg and sperm later merge during fertilization, the embryo is made up of a unique blend of some genes from the father and some from the mother.

To see how chromatin affects meiotic crossovers, Yanowitz and colleagues screened a number of chromatin-related genes. They found that without the gene *xnd-1* (*X nondisjunction*), the X chromosome was defective in crossover formation—probably because of a defective first step in which double-stranded DNA is supposed to break apart and start the crossover process. This finding was surprising: How can the gene target just the X chromosome and have no effect on the rest of the chromosomes, particularly given the fact that the process of crossing over appears to be similar for all chromosomes? Although the *xnd-1* gene primarily affects the X chromosome, it is found on the non-sex chromosomes (called autosomes) and could be working from a distance. The gene may be part of a mechanism to make the autosomes look different from the sex chromosome so that the factors required for starting crossover can better find the X chromosome.

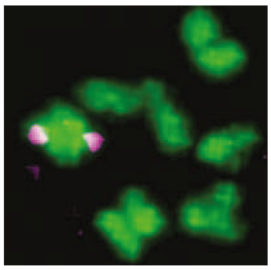
Yanowitz also found that sex, age, and temperature affect the placement of crossovers along the chromosomes, pointing to chromatin architecture as an important regulator of genetic mixing.

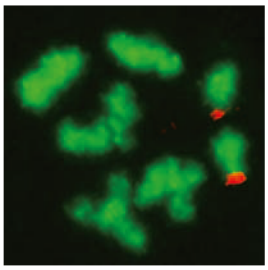
Reining In Jumping Genes

Unlike regular genes, which don't move around the genome, genetic elements called transposons can jump around chromosomes and cause mutations. This behavior can be particularly threatening in cells that give rise to egg and sperm. Fortunately, nature developed a mechanism that employs small RNA molecules known as piRNAs to rein in these jumping genes. But how piRNAs carry out this important function has remained a puzzle. Recent studies by Alex Bortvin and colleagues discovered a protein that may cooperate with piRNAs to restrain jumping genes in mouse sperm. They also found that the protein is crucial to sperm formation and that jumping

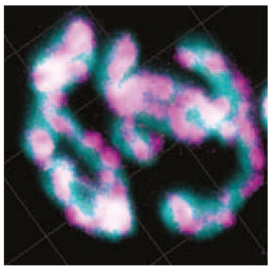
(Above Right) Judith Yanowitz (foreground) and research scientist Cynthia Wagner examining the nematode *C. elegans* at their microscopes.

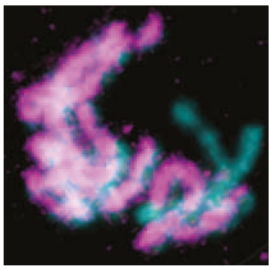
(Left) Undergraduate research assistant Frazer Heinis prepares samples for typing genes.





Chromosomes are held together at the site of the exchange of DNA so that each chromosome pair can be counted prior to cell division. At left, there are six chromosome pairs of the nematode. The pink spots are the X chromosomes held together. At right, the X chromosomes (red) have not exchanged material and are separate. The five larger spots correspond to the non-sex chromosomes.





When chromosome pairs come together to recombine, a "glue" called the synaptonemal complex holds them together. At left, this glue (Syp-1 protein, pink) is seen between all the DNA pairs (blue). At right, in the *xnd-1* mutant the X chromosome glue has come off and the X chromosomes start to splay apart.

Images courtesy Judith Yanowitz

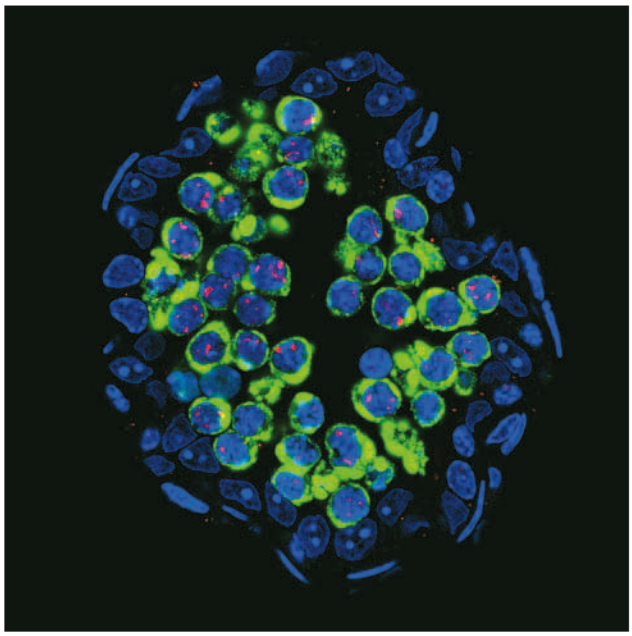
Embryology, *Continued*

genes may be fundamental to sperm development.

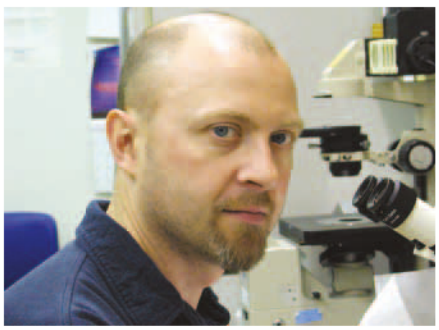
Bortvin and team built on previous studies of the fruit fly by researchers including former Carnegie scientist Toshie Kai, who studied the role of a cell component called nuage in repressing transposons in the female fruit fly. Nuage is exclusive to cells that produce egg and sperm (called germ cells). It was found to be involved in silencing transposons during egg development in fruit flies. To test if the mouse nuage played a similar role in mammals, the Bortvin team focused on the mouse protein Maelstrom—a distant relative to the relevant fruit fly protein.

The scientists first marked Maelstrom with a fluorescent antibody and found that, like the counterpart protein in the fruit fly, it becomes active at the nuage. Then they created mutant mice without the gene that makes the protein and discovered that germ cell division, meiosis, went terribly awry. Transposons were uncontrollably expressed and flooded the cytoplasm and nuclei of the germ cells, killing them. The more transposons there were in the nucleus, the more the chromosomes failed to locate each other during meiosis. Since studies in fruit flies and mice point to nuage, it likely plays a central role across species in silencing jumping genes during egg and sperm development.

The scientists were taken aback to find that the silencing does not occur one time only in the male cells during fetal development. Instead, the jumping genes are activated each time a germ cell divides, but then are quickly silenced, over the course of a mouse's life. This result suggests that germ cells may harness transposons in some fundamental way in male germ cell division. It is the first clue that jumping genes could have a pivotal role in sperm development. □

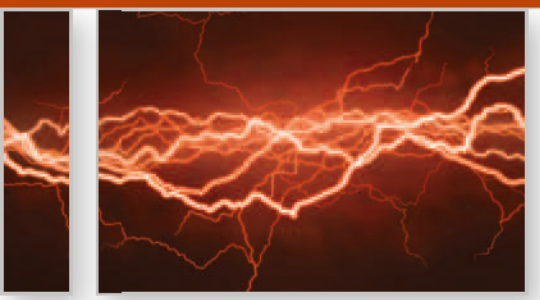


(Above) In the absence of the protein Maelstrom to keep them at bay, jumping genes, called transposons (green), flood germ cells (DNA-blue)—the precursor cells of sperm in the male mouse. (Below) Alex Bortvin. *Images courtesy Alex Bortvin*



Geophysical Laboratory

Probing Planet Interiors, Origins, and Extreme States of Matter



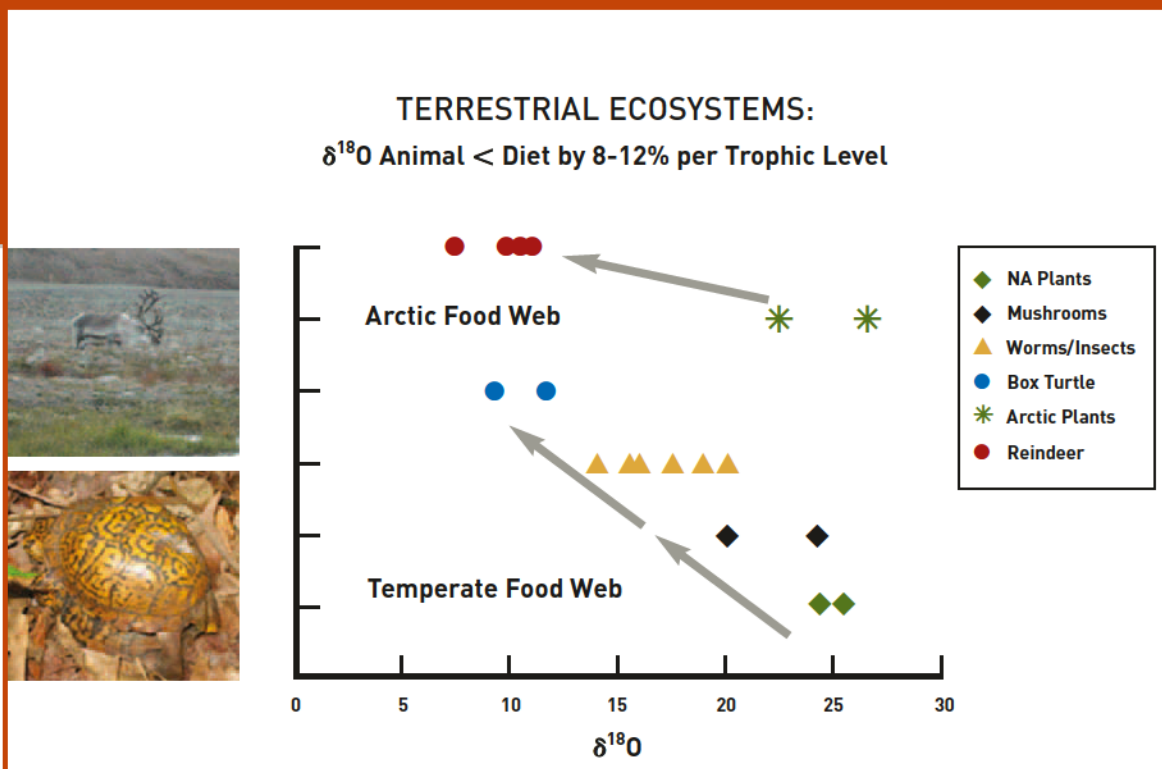
Untangling the Food Web

Creatures really are what they eat. Their diet is frozen into their bones and tissue, leaving a trail that tells what their environment is like and how they interact with their ecosystem. The clues come from concentrations of certain isotopes—atoms with the same number of protons but a different number of neutrons. Oxygen, hydrogen, carbon, nitrogen, and sulfur isotopes are particularly key; their concentrations change depending on chemical processing or temperature. Recently, Marilyn Fogel began to tackle a particularly vexing problem: how oxygen-18 (^{18}O) from tissue can be used to link food webs and hydrology—important information for pinpointing environmental changes and for advancing food-web research.

Although very little is known about how oxygen isotopes are incorporated into biological tissues, scientists have used them for some time to determine latitude, altitude, water cycling, and precipitation, thereby deepening our understanding of ecosystems. With postdoctoral fellow Seth Newsome, Fogel is establishing a new way that ^{18}O, the heaviest oxygen isotope, in tissue can be used to trace food webs. Scientists have believed that the oxygen isotopic composition of an animal is determined by its water consumption. But oxygen in tissues comes not only from drinking water, but also from respiration and food. Fogel and Newsome are determining which types of aquatic and land plants and animals at different levels in the food chain are best for analysis and how seasons, water, metabolism, transpiration, and respiration affect the ratios of ^{18}O in tissue. In studying *E. coli*, a simple bacterium, they are also looking at how the isotope flows from outside to inside cells.

It turns out that ^{18}O becomes progressively depleted at higher levels in the food chain, which the scientists believe results from the separation of lighter from heavier isotopes during the breathing process. They also found major differences among animal groups. Initially, they saw a difference between terrestrial and marine organisms, then among different aquatic organisms. By looking at the

Geophysical Laboratory staff scientist Marilyn Fogel (left) and postdoctoral fellow Seth Newsome (right). *Image courtesy Marilyn Fogel*



Fogel and Newsome found that the relative abundance of the heaviest oxygen isotope, ^{18}O, in terrestrial ecosystems varies by latitude, species, and the feeding level the animals occupy in the food chain. *Image courtesy Marilyn Fogel*

isotopic level, the researchers have established for the first time, in a wide variety of organisms, a means for deciphering how the isotope wends its way into tissue. They also believe that developing multiple tracers of diet will help resolve particularly complex food webs, and that oxygen isotopes may be more important than hydrogen isotopes to understanding aquatic ecosystems.

Not Too Hot to Handle

In Jules Verne's science fiction novel, scientists traveled to the center of the Earth. But in real life they have to devise methods to imitate the extreme temperatures and pressures there to understand the internal dynamics that drive the Earth's evolution and that create phenomena we observe much nearer to the surface, such as earthquakes and volcanoes. Until recently, researchers did not have the capability to measure how heat moves through the deep interior. Alexander Goncharov and colleagues broke this barrier by developing a new procedure to observe how heat is transferred through mantle minerals. They found that the concentration of iron in silicate perovskite and ferropericlase—the two major mantle minerals—is key to moving heat.

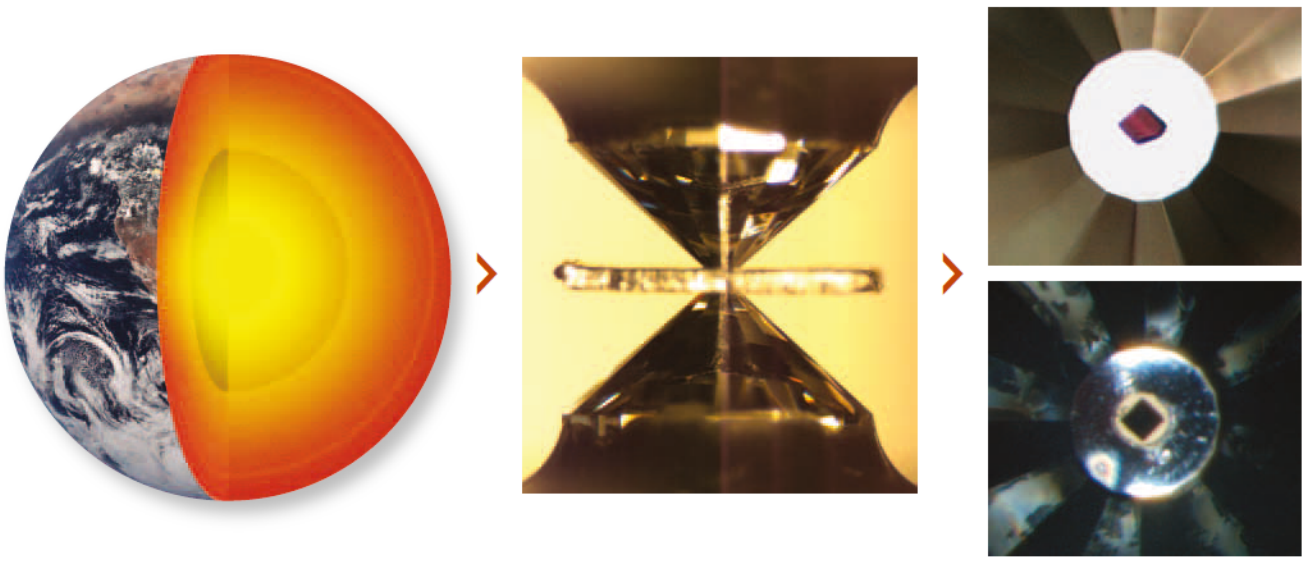
The lower mantle sits on top of the core and is about 400 to 1,800 miles (660 to 2,900 kilometers) deep. Pressures range from 23 gigapascals, which is about 230,000 times the pressure at sea level (atmospheres), to 1.3 million atmospheres. Temperatures are brutal—ranging from about 2,800 to 6,700 degrees Fahrenheit. Silicate perovskite is believed to constitute about 80% of

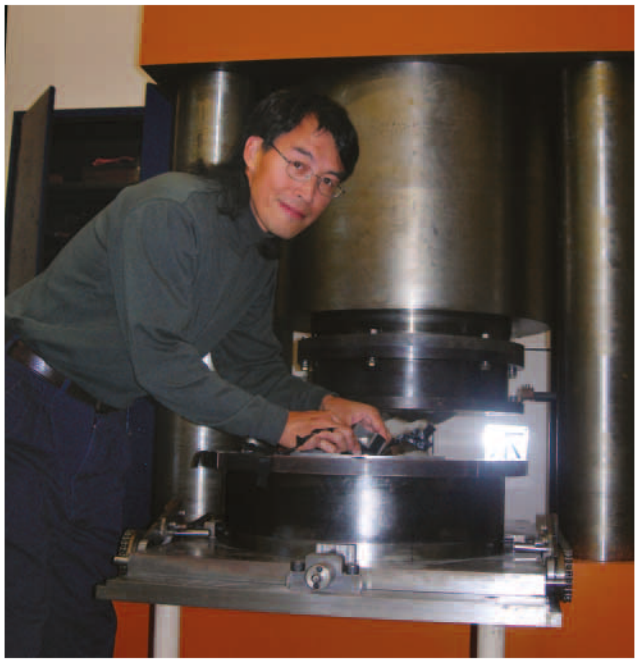
the mantle, while ferropericlase makes up the rest. Both minerals contain between 10% and 20% iron, and its presence strongly influences properties such as density, sound velocity, heat diffusion, and conductivity. Under these extreme conditions, the atoms and electrons of iron are squeezed so close that spinning electrons are forced to pair up. When this spin state changes from unpaired electrons—a high-spin state—to paired electrons—a low-spin state—other properties also change.

Goncharov and team—Ben Haugen, Viktor Struzhkin, Pierre Beck, and Steve Jacobsen—developed a new optical spectroscopy system to measure optical spectra, from infrared through ultraviolet wavelengths, and the energy dissipation rate through radiometry. They subjected the minerals to pressures up to 1.3 million atmospheres at room temperature and subjected ferropericlase to 640,000 atmospheres at temperatures to 980°F.

The scientists found that heat absorption is governed by the concentration of ferrous ($Fe^{2}+$) iron in ferropericlase and ferric ($Fe^{3}+$) iron in silicate perovskite. They also noted changes in absorption related to the spin-state transition, but the effects were smaller. The results suggest that the radiative thermal conductivity is smaller than previously thought, which is important for understanding mantle dynamics, including the generation and stability of thermochemical plumes.

To study the Earth's interior (left), scientists replicate the extreme pressure conditions there by squeezing samples of interior minerals between two diamond tips (middle image). They then measure the changes each sample undergoes (right image). *Images courtesy Steve Jacobsen*





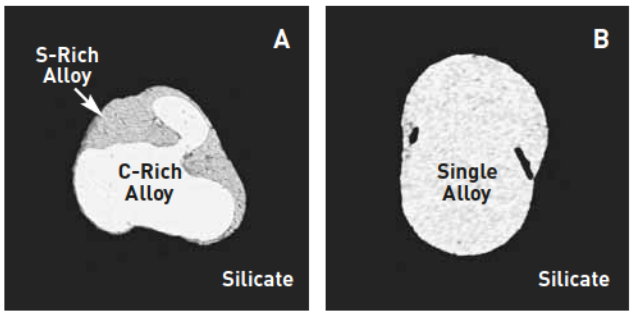
Yingwei Fei loads a sample for analysis in the Geophysical Laboratory's multianvil lab.
Image courtesy Yingwei Fei

Lightening Up the Earth's Core

Since its discovery in 1906 from seismic data, the Earth's core has intrigued geoscientists. Formed chiefly of iron, it is extremely dense, accounting for nearly a third of the planet's mass despite occupying only an eighth of its volume. Yet the core also exhibits what researchers such as Yingwei Fei call a density deficit. That is, neither the liquid outer core nor the solid inner core is as dense as would be expected if the core were pure iron. This suggests that lighter elements must also be present.

But which elements? Sulfur, carbon, silicon, oxygen, and hydrogen are possible candidates. Fei and colleagues have been systematically investigating how these lighter elements form alloys with iron at high pressure and temperature, with particular attention to the iron-sulfur-carbon system. Sulfur can dramatically lower iron's melting temperature, suggesting that molten iron-sulfur mixtures present during the Earth's hot early days would have been relatively quick to percolate downward to create the primordial core. On the other hand, carbon is extremely abundant in the Solar System and binds readily to iron, so it may also have been part of the mix.

Fei and his collaborators melted mixtures of pure iron, iron sulfide, and carbon in differing proportions while subjecting them to pressures up to 250,000 atmospheres. They found that at pressures below and above 50,000 atmospheres the mixtures melt differently. Below 50,000 atmospheres the melt tended to separate into two immiscible liquids, one sulfur rich and the other carbon rich, in a manner analogous to oil and vinegar in salad dressing. Above 50,000 atmospheres this tendency disappeared, however. The researchers also found that when the melts solidify, the carbon becomes concentrated in the solids, while the sulfur tends to remain in the liquid. These results imply that within the Earth's core sulfur is primarily concentrated in the liquid outer core, with carbon concentrated in the solid inner core. The presence of carbon in the core, even as a minor constituent, would make it the largest carbon reservoir on Earth. □



Electron microscope images show experimental samples at low and high pressure. At pressures below about 50,000 times the atmospheric pressure at sea level, sulfur-rich and carbon-rich molten alloys of iron exist as separate fluids in a silicate matrix (A). But at pressures above this level (B), there is complete miscibility and a single alloy is present. Scale bars are 25 microns (0.025 mm).
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Global Ecology

Linking Ecosystem Processes with Large-scale Impacts

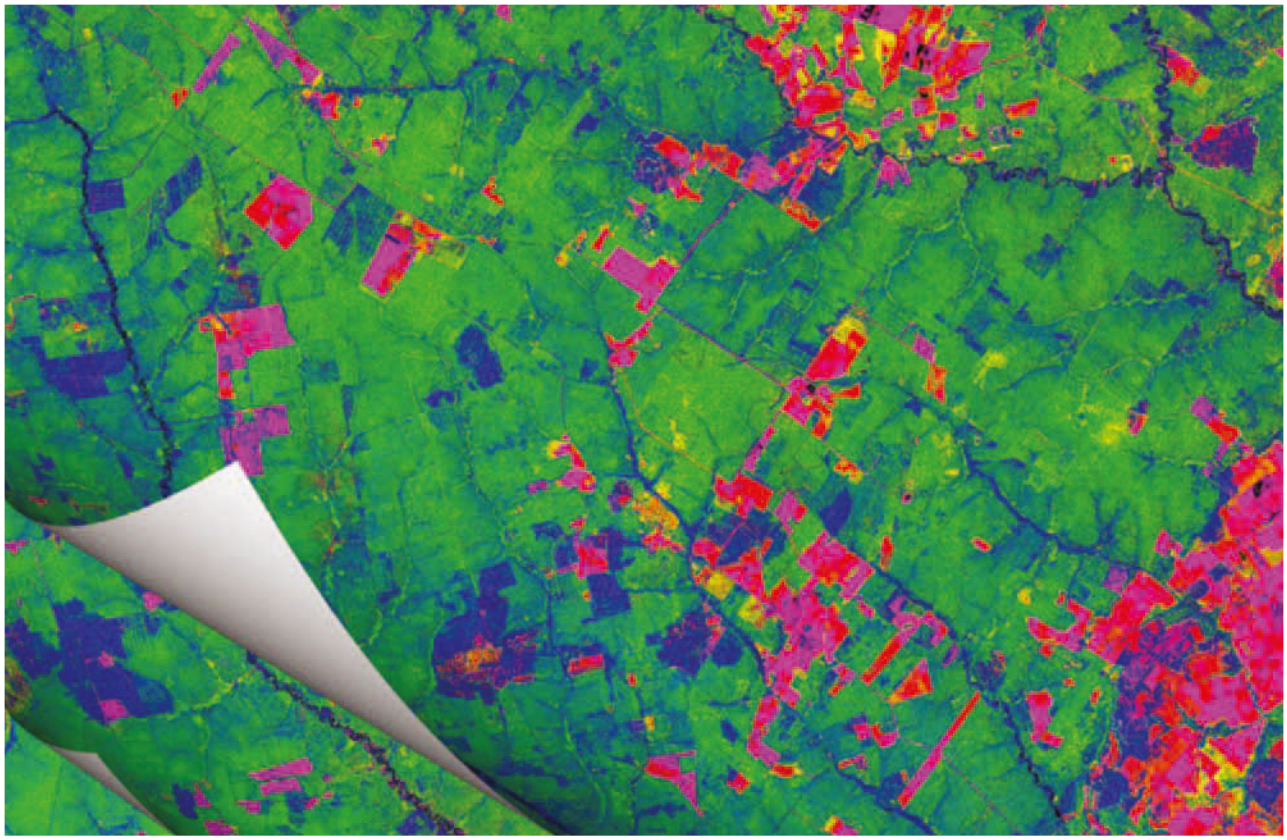
CLAS Goes Lite and Wide

A slew of satellites look down on our planet, making cell phones, weather prediction, global positioning, and other everyday conveniences possible. Greg Asner and team have developed new technology to work with one of the oldest satellite systems—Landsat. Their tool grew out of his team's Carnegie Landsat Analysis System (CLAS) and allows researchers in tropical nations to monitor rain forest disturbances from their desktops. Dubbed CLASLite, the new technology is very user friendly, promising to revolutionize deforestation mapping and help rain forest nations better understand their carbon budgets.

The first remote sensing Landsat satellite was launched in the early 1970s, but analysis techniques could not penetrate the upper layers of forest leaves. Beginning in 1999, Asner started analyzing satellite imagery of Brazilian rain forests using advanced computational methods that he developed with programmer Dave Knapp. CLAS's image analysis and pattern-recognition algorithms can penetrate the canopy all the way to the soil at a scale of about 100 square feet. The intricate computations were run on the lab's large cluster of computers to detect minute differences in vegetation patterns and produce detailed vegetation maps. This enabled detection of clandestine logging activities—the removal of a few valuable trees—that previously had escaped notice. Over four years, Asner and team found that Brazilian rain forest destruction had been underestimated by half—critical information for the Brazilian government and nongovernmental organizations (NGOs) concerned about deforestation.

Although the Asner group spent years improving CLAS in Brazil, they were able to complete a study in Peru in just one year with their advanced software. They found that rain forest protection measures are working well in that Amazon nation. Shortly thereafter they took CLAS to Borneo.

Over the past year, Asner and Knapp retooled CLAS to be more user friendly and to work on desktop computers so that even the smallest government agency or NGO can observe what is happening to the rain forests. During 2008, they trained 35 Peruvians on the CLASLite system. They now plan to extend the training and technology transfer to other countries around the globe, beginning with Ecuador, Colombia, and Bolivia. With support from the Gordon and Betty Moore Foundation, Asner is working to certify CLASLite as a standard forest-monitoring tool for the proposed United Nations program to reduce carbon dioxide emissions from deforestation and forest degradation.



This output from CLASLite shows deforestation (bare soil) in pink and forest disturbance from logging in blue in the Brazilian Amazon. The map depicts changes through time with each successive overlay.

Image courtesy the Asner lab

Putting Biofuels on the Map

Location, location, location: it's a key to success in real estate. Could it also be a key to the successful development of biofuels? Much of the media attention on biofuels has focused on the pros and cons of specific bioenergy crops and the technologies for converting them to fuel. But for biofuels to be a realistic and environmentally friendly solution to the world's energy woes, location clearly matters. Converting forestlands to cornfields or other bioenergy croplands could worsen the problem of global warming by emitting the carbon stored in forest trees and soils. And converting croplands currently used to grow food threatens the global food supply.

Global Ecology's Biofuel Project, led by department director Chris Field, is investigating the potential for developing bioenergy agriculture on currently abandoned or degraded agricultural lands. Field's team estimated the global extent of abandoned crop- and pastureland, calculating their potential for sustainable bioenergy production from historical land-use data, satellite imaging, and ecosystem models. Agricultural areas that have been converted to urban areas or that have reverted to forests were not included in the assessment.

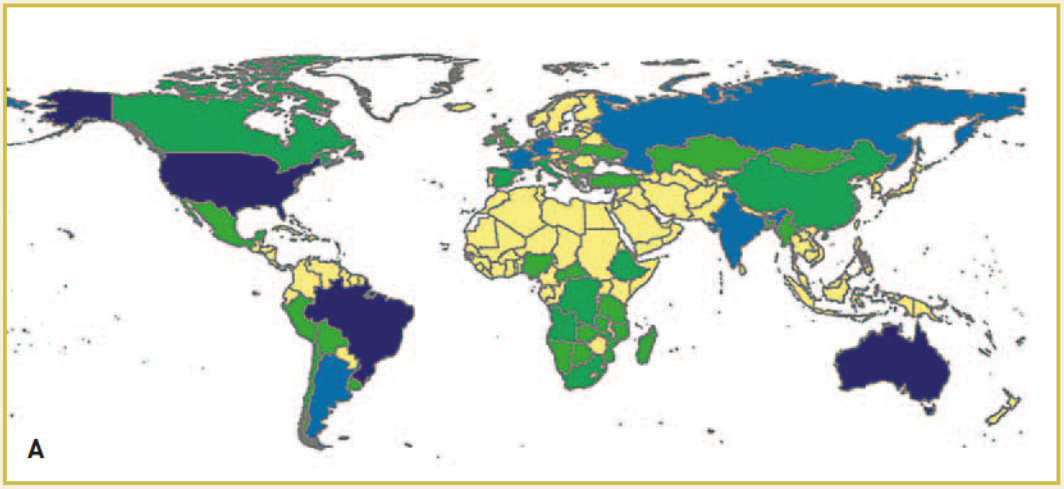
According to the study, up to 4.7 million square kilometers (approximately 1.8 million square miles)

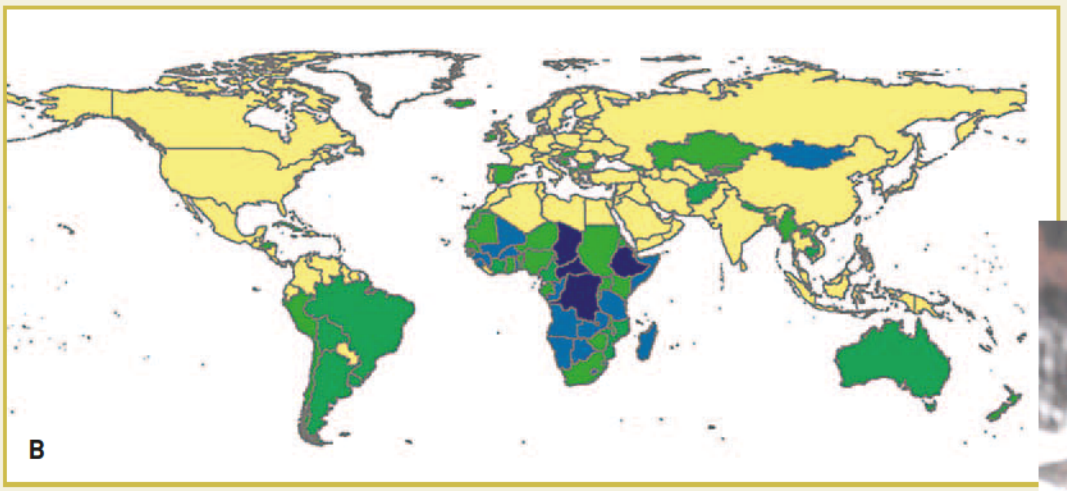
of abandoned lands could be made available for growing energy crops. The potential yield of these lands, equivalent to nearly half the land area of the United States (including Alaska), depends on local soils and climate as well as on the specific energy crops and cultivation methods in each region. But the researchers estimate that the worldwide harvestable dry biomass could amount to as much as 2.1 billion tons, with a total energy content of about 41 exajoules (one exajoule is a billion billion joules, equivalent to about 170 million barrels of oil).

This sustainable bioenergy, grown on the available lands within the borders of each country, would likely satisfy 10% or less of the total energy demand in the energy-intensive economies of North America, Europe, and Asia. But for some developing countries, notably in sub-Saharan Africa, it could potentially supply many times their current energy needs without compromising the food supply or destroying forests. □

(Left) Sometimes old-fashioned tools are needed in a high-tech project. Greg Asner works in the field. (Right) David Knapp operates sophisticated instrumentation in many remote regions. *Image courtesy Asner lab*

Global Ecology, *Continued*





Potential Production on Abandoned Agriculture (million ton y^{-1})

- 0 - 5
- 5 - 16
- 16 - 39
- 39 - 95
- 95 - 321

Bionenergy: Primary Demand (EJ y^{-1} : EJ y^{-1})

- 0.0 - 0.1
- 0.1 - 0.5
- 0.5 - 1.0
- 1.0 - 5.0
- 5.0 - 75.0

Potential biofuel production on previously abandoned agricultural land is highest in the United States, Brazil, and Australia (A), but local production is most likely to meet domestic needs in developing countries where energy demand is low, such as in sub-Saharan Africa (B). Energy production is measured in exajoules per year (one exajoule is equivalent to approximately 170 million barrels of oil).

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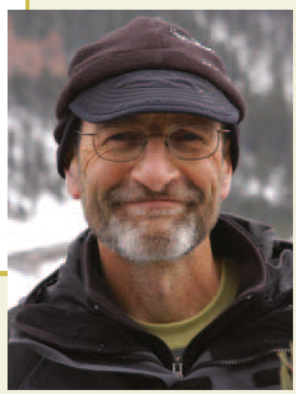
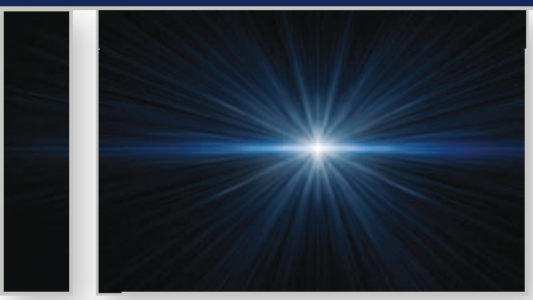


Carnegie's Chris Field

Observatories

Investigating the Birth, Structure, and Fate of the Universe



New MagE Spectrograph a "Hit"

In science, as in baseball, you don't always have to swing for the fences to get results. Sometimes you are better off going for base hits. That's how Stephen Shectman describes the philosophy behind the latest generation of instruments built for the Magellan telescopes. The original set of instruments built for the 6.5-meter telescopes at the Las Campanas Observatory in Chile were ambitious, general-purpose analytical tools. The new instruments being built for the telescopes are simpler, less expensive, and geared to address more specialized questions.

For example, the newly commissioned Magellan Echellette, or MagE, spectrograph is optimized to analyze light from faint ultraviolet targets. Built collaboratively with MIT, MagE was installed on the Magellan Clay telescope in late 2007. At its heart is an echellette grating, a specialized type of diffraction grating consisting of closely spaced angular grooves on a mirror. Using the diffraction effect (the same optical phenomenon that creates the play of colors on the surface of a compact disk) to split starlight into its constituent wavelengths, diffraction gratings typically produce higher-resolution spectra than prisms. But unlike prisms, they produce multiple overlapping spectra, called orders, from a single beam of light. The grooves of echellette gratings are cut or "blazed" at a specific angle to enhance particular diffraction orders and wavelengths. The problem of overlapping orders is solved by orienting prisms to deflect light at right angles to the spectra, stacking the orders neatly one above the other. As a result of this optical legerdemain, the MagE spectrograph can efficiently analyze 15 orders at once over a broad sampling of wavelengths, including the ultraviolet realm.

With Ian Thompson, Hsiao-Wen Chen, Scott Burles, and Jennifer Marshall, Shectman has already begun to put MagE through its paces, hunting for metal-poor stars in the galactic bulge and studying the absorption spectra of light passing through gas clouds in the halos of nearby galaxies. MagE's heightened response at ultraviolet wavelengths is key to both efforts.

Other specialized instruments are on deck for the Clay telescope, including the new Planet Finder Spectrograph (PFS), optimized for discovering extrasolar planets. Developed by Shectman with Jeffrey Crane and Terrestrial Magnetism's Paul Butler, the PFS should go into operation in mid-2009.

Star Birth at the Edge

Massive, high-luminosity stars live fast, die young, and never make it far from their place of birth. This makes them useful beacons for delineating regions of currently active star formation within galaxies. Unfortunately, these newborn stars emit most of their light at ultraviolet wavelengths, which are largely blocked by the Earth's atmosphere. To rise above the problem, NASA launched the *Galaxy Evolution Explorer* spacecraft, or GALEX, in

(Above) Carnegie's Ian Thompson (left) and Scott Burles (right) of MIT prepare to mount MagE's electronics package for the CCD detector on the instrument in the lab in Pasadena before it is shipped to Chile.

(Left) Mechanic Felix Quiroz (left) and instrument specialist Mauricio Navarrete (right) look on as the instrument is hoisted into position on the Magellan Clay telescope on November 20, 2007.

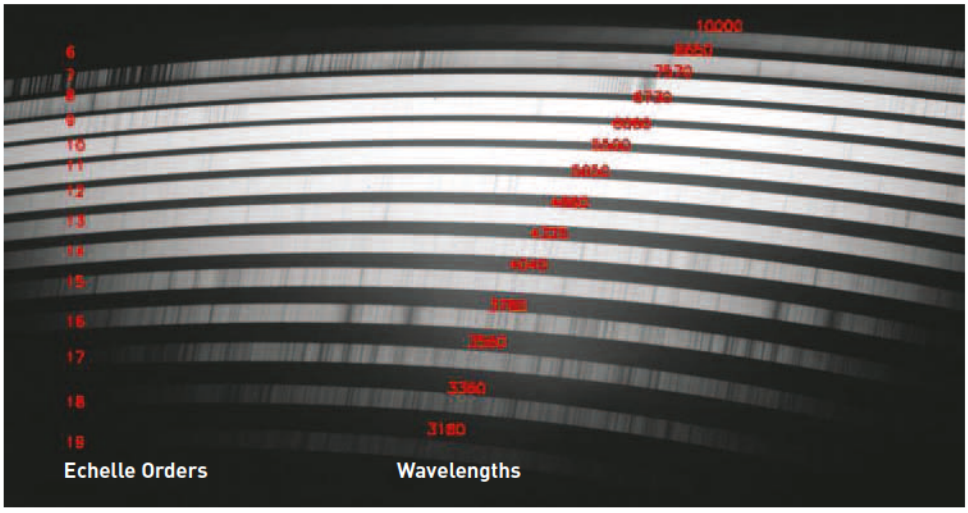
Images courtesy Stephen Shectman

2003. With detectors sensitive to both near and far ultraviolet wavelengths, GALEX has given astronomers, such as the Observatories' Barry Madore, a new set of eyes on the universe.

Perhaps the most significant of GALEX's findings has been the discovery of extended ultraviolet disks around many nearby galaxies. These bright ultraviolet-emitting regions of star formation can extend up to four times the diameter of the galactic disks observable in visible light. Of the galaxies described by Madore and colleagues in the recently published GALEX Ultraviolet Atlas of Nearby Galaxies, 30% of the spiral galaxies show extended UV disks, suggesting active star formation in these regions.

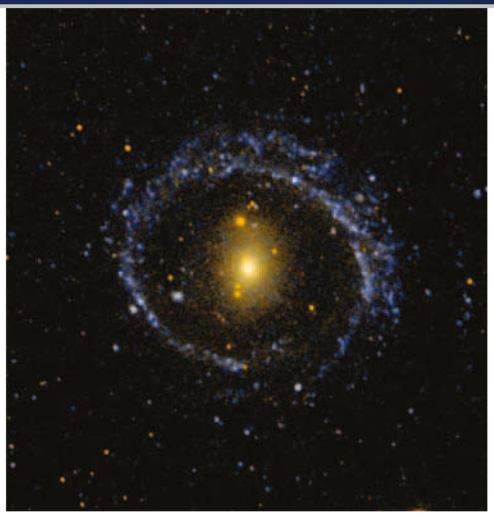
The outer reaches of galactic disks were believed to be unlikely regions for star formation because it was expected that the gas and dust out of which stars might condense would be spread too thinly. Below a certain threshold no stars could form—or so it was thought. But the presence of these extended UV disks shows that stars are in fact actively forming and that there is no lower threshold of gas density for producing stars. Star formation tails off as the disks thin, but it is not abruptly truncated.

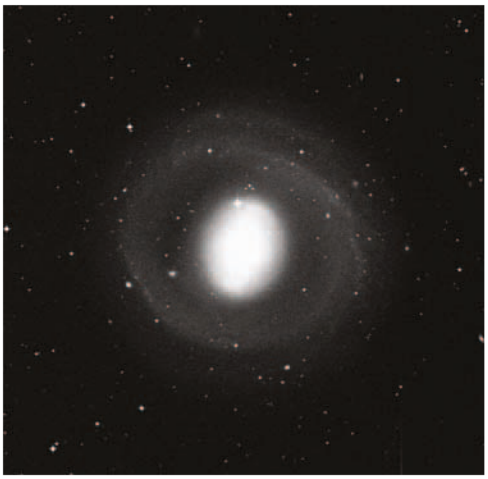
It has long been known that there are untapped reservoirs of gas at large radii in many galaxies. How this gas accumulates and what acts as the trigger for star formation is still an active topic of research with implications for galaxy formation and evolution. Interactions among galaxies undoubtedly play a role in the formation of extended UV disks, but the GALEX observations suggest that even isolated galaxies know how to store fuel and trigger star formation far from their centers. □



The image shows a solar spectrum taken by the MagE spectrograph, with diffraction orders numbered 6 through 19. Central wavelengths of the orders range from 3180 to 10,000 angstroms; the spectrum covers the entire range of optical wavelengths transmitted by the atmosphere. MagE's ability to simultaneously analyze optical spectra in up to 15 orders will be a boon to researchers. *Image courtesy Stephen Shectman*

Observatories, *Continued*



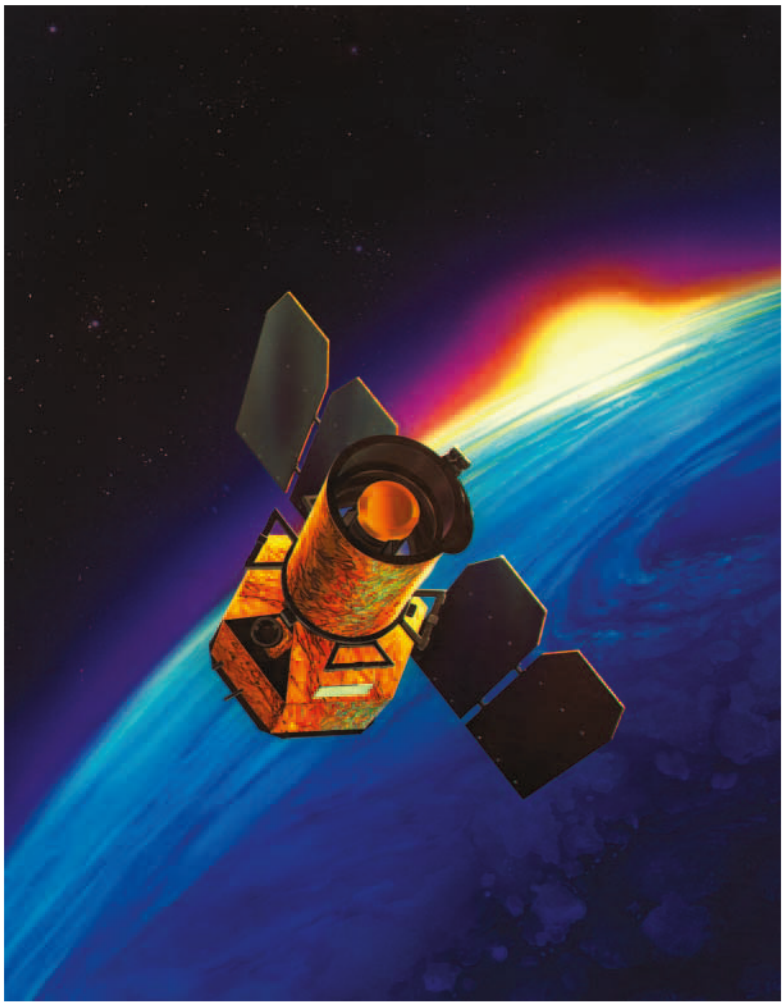


This pair of images shows the galaxy NGC 1291 in ultraviolet (top) and visible light (bottom). The ultraviolet image, taken by NASA's *Galaxy Evolution Explorer*, reveals bright regions of young stars in the galaxy's outer disk. It was previously thought that star-forming materials were too sparse in these outer zones for new stars to form. NGC 1291 is located about 33 million light-years away in the constellation Eridanus.

Images courtesy NASA/JPL-Caltech/SSC and the Palomar

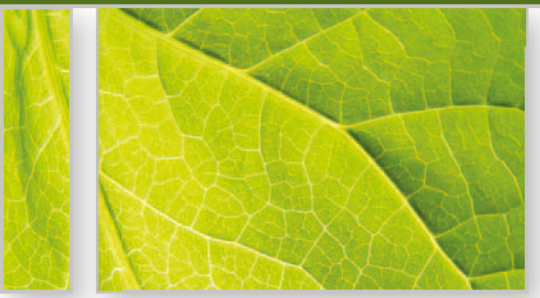
The *Galaxy Evolution Explorer* (GALEX) was launched on April 28, 2003. Its mission is to study the shape, brightness, size, and distance of galaxies across 10 billion years of cosmic history by making observations at ultraviolet wavelengths.

Image courtesy NASA/JPL-Caltech



Plant Biology

Characterizing the Genes of Plant Growth and Development



LITTLE ZIPPER Keeps Leaves Right Side Up

Leaves are the factories that turn sunlight and atmospheric carbon dioxide into carbohydrates and oxygen. Through evolution, they have developed into highly efficient, organized structures: cells specializing in light capture are packed tightly in the upper half of the leaf, while cells responsible for gas exchange are typically on the bottom. This asymmetry is genetically controlled early during the emergence of the leaf primordium from the meristem—the growing point of the plant.

Kathryn Barton's lab has examined how the upper and lower regions of the leaf become distinct during early leaf development. Using the reference plant *Arabidopsis*, her lab studies the regulatory network that controls leaf asymmetry. This year the researchers discovered a new family of *LITTLE ZIPPER* genes responsible for giving the leaf its unique organization.

A protein named REVOLUTA was already known to be a powerful promoter of upper leaf development by activating genes required to give the upper leaf half its unique characteristics. However, until now, the "target" genes that REVOLUTA affects had not been identified.

The key to discovering the *LITTLE ZIPPER* genes was to engineer the REVOLUTA protein to control the genes' activity. John Emery attached a section to the REVOLUTA protein that renders it inactive unless the steroid dexamethasone is added. This engineered protein was introduced into *Arabidopsis*, where, when activated, it started the "program" that drives upper leaf development. Stephan Wenkel found that within 30 minutes of activating the REVOLUTA protein, four previously undescribed *LITTLE ZIPPER* genes were turned on. This remarkable family has the ability to "zipper" with and then inactivate the REVOLUTA protein through a feedback loop, which happens through compatible "leucine zipper" domains.*

When a plant is engineered to make too much of the ZIPPER3 protein, the stem cells in the meristem—the tip of the shoot—are used up in making a single terminal leaf. This leaf lacks the correct machinery for establishing the normal top/bottom polarity in the leaf, which develops as the spike-like structure in the middle. *Image courtesy Kathryn Barton*

*Leucine zipper domains were first described by Carnegie trustee Steven McKnight when he was a staff member at Carnegie's Department of Embryology.

The *LITTLE ZIPPERS* complete the feedback loop, keeping the REVOLUTA protein in check in cells where it needs to remain dormant. Wenkel also found that the *LITTLE ZIPPER* proteins—products of the genes—limit the growth of stem cell populations in the plant, another indication of how important the *LITTLE ZIPPERS* are to plant growth and development.

Now the team will explore a new series of questions: What breaks the feedback loop in cells where the REVOLUTA protein must be active? What do the dozens of REVOLUTA target genes do?

New Twist on Life's Power Source

Photosynthesis is arguably the most important biological process on Earth. Through photosynthesis, plants, algae, and some bacteria support nearly all living things by producing food from sunlight. In the process, they alter the atmosphere by releasing oxygen and absorbing carbon dioxide. But research by Plant Biology's Arthur Grossman and Shaun Bailey, with colleagues, suggests that certain marine microorganisms have evolved a way to break the rules—they get a significant proportion of their energy from the Sun without a net release of oxygen or uptake of carbon dioxide. This discovery not only impacts scientists' basic understanding of photosynthesis, but importantly, it may also impact our measurements of primary productivity in the ways that microorganisms in the oceans might influence rising levels of atmospheric carbon dioxide.

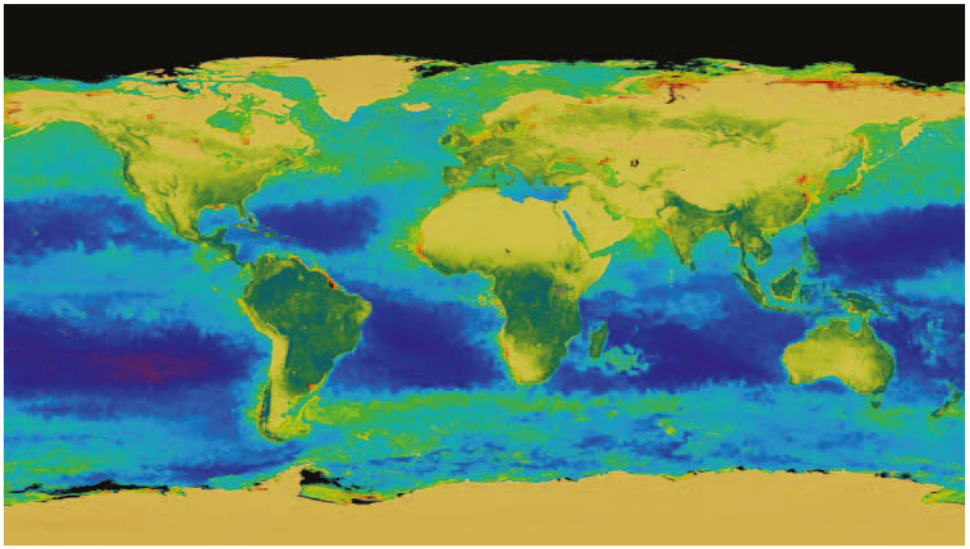
Grossman's team investigated photosynthesis in a marine *Synechococcus,* a genus of cyanobacteria (formerly called blue-green algae). *Synechococcus* dominates phytoplankton populations over much of the world's oceans and is an important contributor to global primary productivity. Grossman and his colleagues wanted to understand how *Synechococcus* could thrive in the iron-poor waters that make up large areas of the ocean, since certain activities of normal photosynthesis require high levels of iron.

It turns out that *Synechococcus* solves the iron problem by short-circuiting the standard photosynthetic process, reducing the levels and activities of those stages in photosynthesis that require the most iron. These are also the stages in which carbon dioxide is taken from the atmosphere. Grossman and Bailey have tentatively identified the enzyme involved in this process as plastoquinol terminal oxidase, or PTOX.

This prominent phenomenon in oligotrophic ocean picophytoplankton studied in the laboratory was also shown to occur in nature by Stanford University graduate student Kate Mackey, who made direct measurements of photosynthesis in field samples from the Atlantic and Pacific oceans. This may mean that primary productivity of the oceans is lower than expected from pigment levels. As a result, it may be important to consider this aspect of photosynthesis when predicting CO_2 removal from the atmosphere by open-ocean photosynthetic organisms. These findings, together with corroborating evidence reported by other groups, especially Cardol, Finazzi, and Wollman in France, will add depth to and a mechanistic foundation for the modeling of primary productivity in the ocean.

Plant Biology's Kathryn Barton

Image courtesy Joel Grimes



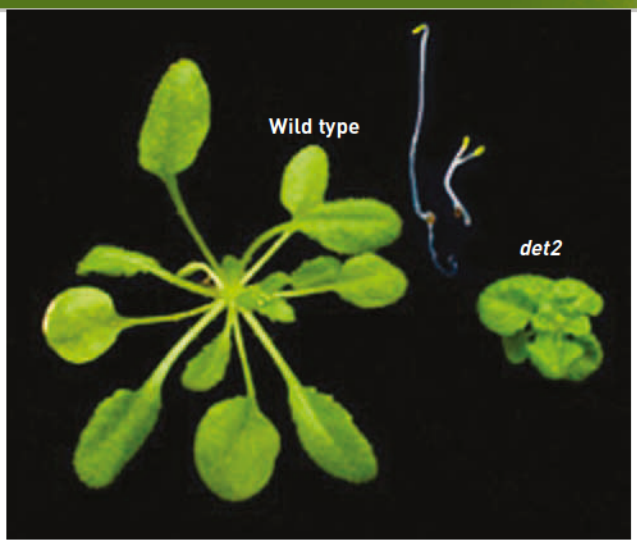
This satellite image shows the amount of chlorophyll present globally. Low levels of chlorophyll in oligotrophic (nutrient-poor) regions of the oceans appear purple and blue. *Synechococcus* dominates the phytoplankton assemblage in these areas.

Image courtesy the SeaWiFS Project and the NASA Goddard Scientific Visualization Studio

Finding the Missing Links

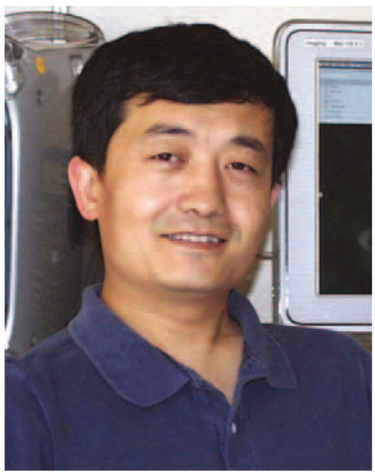
Steroids bulk up plants just as they do human athletes, but in plant cells the molecular machinery through which steroids regulate the genes to boost growth and development is far more elaborate than in human cells. Animal cells respond to steroids via receptor molecules within the cell nucleus, whereas plants respond to the steroid hormone brassinosteroid (BR) through receptors on the outside of the cell membranes. A challenge for researchers has been to piece together the steps by which the hormonal signal is transmitted from the cell surface receptor to genes in the nucleus. Although several proteins that relay the BR signal have been identified,

Plant Biology, *Continued*



Brassinosteroids (BRs) are important growth hormones throughout the plant kingdom. BR-deficient mutants, such as *det2* (right), show dramatic developmental defects such as dwarfism, as seen in the photo, as well as male sterility and other deficiencies.

Image courtesy Zhi-Yong Wang



Wenqiang Tang (left), a postdoctoral associate working with Zhi-Yong Wang (right), was lead author for the *Science* paper on the brassinosteroid signaling pathway. *Image courtesy Zhi-Yong Wang*

the pathway has remained incomplete. Understanding this signaling cascade may help engineering efforts to alter plant architecture and to produce higher plant yield, important features of future food and bioenergy crops.

To identify missing links in the plant's steroid signal transduction chain, Zhi-Yong Wang, with postdoc Wenqiang Tang, used a technique called comparative proteomics to identify changes in the protein pattern specifically induced by exposure of plants to the hormone. Since the signal originates from receptors at the cell membrane, the researchers focused their analysis on fractions enriched in the cell membrane. Two new proteins that were named brassinosteroid-signaling kinases (BSK1 and BSK2) altered their running behavior on two-dimensional gel separations in response to brassinosteroid addition. Follow-up analyses confirmed that BSKs function as the immediate targets of the brassinosteroid receptor BRI1 in the membrane, bridging between the receptor on the membrane and the soluble regulator proteins inside the cell.

Brassinosteroids are key growth hormones throughout the plant kingdom, regulating many aspects of growth and development. Understanding how BRs activate genes could lead to enhanced harvests. Finding BSKs not only fills a major gap in the BR signaling pathway but also may have broader implications for cell signaling. Plant cells contain hundreds of receptor kinases and a number of proteins similar to BSKs, so it is tempting to speculate that these represent missing connections in other signaling cascades. □

Terrestrial Magnetism

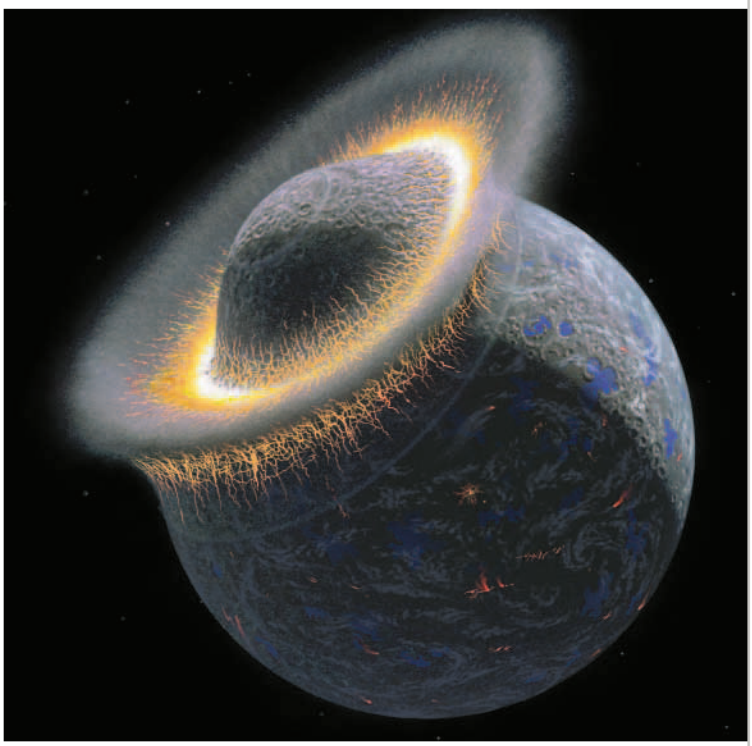
Understanding Earth, Other Planets, and Their Place in the Cosmos

Water on the Moon!

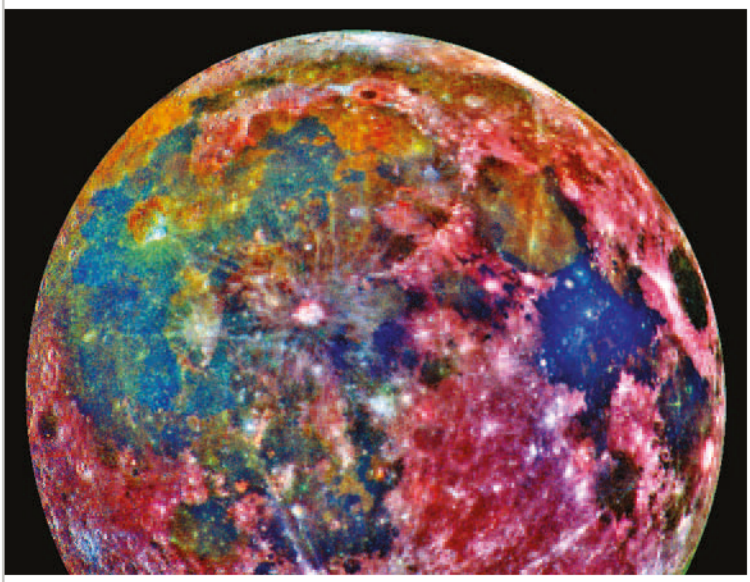
From analyses of material collected by the *Apollo* missions, scientists concluded decades ago that the Moon was dry. But new techniques developed by Terrestrial Magnetism's Erik Hauri have confounded this notion and challenged the long-standing "giant impact" theory of the Moon's formation.

For over 40 years scientists have tried to determine the content and origin of volatiles on the Moon—these volatiles, particularly water, are elements or compounds that evaporate easily. Previously, the limit for detecting volatile water in lunar rocks was about 50 parts per million (ppm). By refining the technology of secondary ion mass spectrometry, Hauri can detect as little as 5 ppm of water. He and his team (including visiting investigator Alberto Saal and former Carnegie Fellow James Van Orman) found considerably more water—up to 46 ppm—in tiny beads of volcanic glass from two Apollo sites. The finding means that H_2O was not entirely lost when the Moon formed and suggests that the water emerged from the lunar interior via volcanic eruptions over 3 billion years ago.

The long-standing belief is that the Moon was formed when a Mars-sized body collided with Earth about 4.5 billion years ago. The collision very likely melted both



The artwork at right depicts what could have occurred under the "giant impact" theory, which proposes that a Mars-sized body collided with Earth about 4.5 billion years ago. The collision melted both objects and sent molten debris and vaporized material into orbit around the Earth, some of which formed the Moon. It had earlier been thought that volatiles were lost from this debris before the Moon coalesced. The new study calls into question how much of the volatiles ended up inside the Moon as it formed and cooled. *Image courtesy © Don Davis*



(Above) This 1992 false-color photograph of the Moon shows differences in soil composition. Blue and orange are ancient lava flows, while red indicates highlands. The recent analysis of volcanic soil from two *Apollo* missions points to the probability that the Moon may have once had water. *Image courtesy NASA/JPL*

(Below) Erik Hauri developed the techniques to detect extremely minute quantities of water in volcanic glasses and minerals using a technology called secondary ion mass spectrometry (SIMS).

objects and sent molten debris into orbit around the Earth, some of which formed the Moon. The heat from the giant impact would have vaporized water and other elements of similar volatility.

The researchers found that one volcanic glass bead exhibited a decrease in volatiles from the tiny sphere's core to its rim. James Van Orman wrote the numerical model that matched the profiles for all the volatiles, including the water. It showed that a droplet cooling from 3°F to 6°F per second over 2 to 5 minutes between eruption and "freezing" lost 95% of the water.

The scientists estimated that the magma at eruption time had about 750 ppm of water, implying that the Moon's interior might have had as much water as the Earth's modern upper mantle. But where did all that erupted water go? Hauri believes that since the Moon's gravity is so weak, some of it was forced into space, but some may have drifted toward the cold lunar poles, where ice may still be present in permanently shadowed craters. Two upcoming NASA missions will address this intriguing question.

Reuniting with Mercury after 33 Years

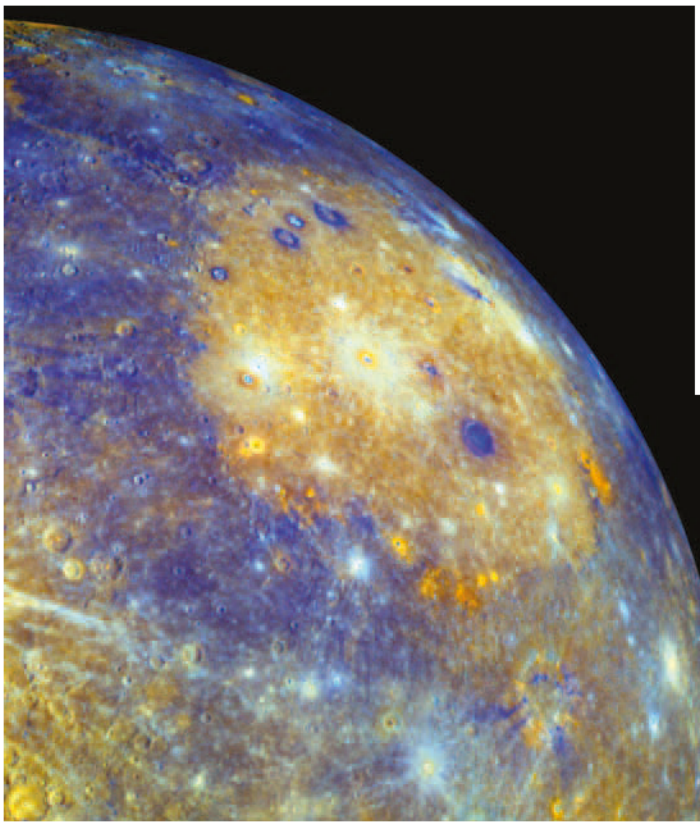
On January 14, 2008, the MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) craft flew 125 miles (200 kilometers) above Mercury's surface and made history: it viewed part of the planet never seen by a spacecraft before. Sean Solomon, director of Terrestrial Magnetism, leads the mission as its principal investigator. With over 1,200 images and other data, the brief flyby settled a 30-year debate about the origins of Mercury's smooth plains; it shed light on the source of its magnetic field; and it produced myriad surprises.

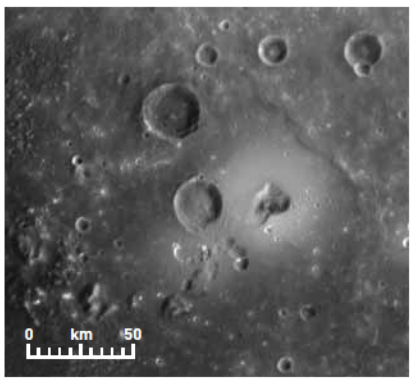
In 1972, the *Apollo 16* Moon mission suggested that some lunar plains originated from material ejected from impacts, which formed smooth "ponds." In 1975, *Mariner 10* saw similar features on Mercury. Some scientists believed that the same processes were at work; others thought that Mercury's plains came from erupted lavas. But the absence of volcanic features in *Mariner 10* images

left the question hanging. MESSENGER's flyby confirmed that once-active volcanoes helped form the plains.

Of the terrestrial planets, only Earth and Mercury have magnetic fields. A hot, churning, liquid-iron core produces Earth's. But Mercury's has puzzled scientists because its iron core should have cooled, turning off the dynamo that produces a magnetic field. Some believe the magnetism is frozen in the outer crust. MESSENGER did not find evidence of this, but it did demonstrate that Mercury's field is dominantly dipolar, with north and south magnetic poles, which suggests that the core generates magnetism. The full answer awaits orbit in 2011.

MESSENGER found that huge cliffs, called lobate scarps, dominate the planet's tectonic landforms. The scarps formed over great faults created as the core cooled and the planet contracted. The mission discovered that the global contraction is at least one-third greater than previously thought.





(Above) This smooth dome is characteristic of a volcano. The center kidney-shaped dimple is surrounded by a bright halo, which the scientists believe was deposited by an explosive eruption on Mercury.

Image courtesy Science *magazine/AAAS*

(Left) This false-color image shows the Caloris Basin (orange circle) and adjacent areas. The orange spots inside the basin indicate the location of the kidney-shaped depression and related features. The different-colored craters indicate excavated material of different composition. Some were modified by post-impact volcanic activity.

Image courtesy Science *magazine/AAAS*

Sean Solomon, principal investigator of the MESSENGER mission and director of the Department of Terrestrial Magnetism, responds to a question about the flyby during the press briefing at NASA Headquarters.

The flyby also made the first-ever observations of ions—charged particles—including water ions in Mercury's unique exosphere, an ultrathin atmosphere. Ions heavier than hydrogen and helium come from the planet's surface. MESSENGER confirmed that there is strong variation in the exosphere over time, caused by the planet's highly elliptical orbit, slow rotation, and interactions between the solar wind and Mercury's bubble-like magnetosphere, generated by the planet's magnetic field. MESSENGER was additionally the first spacecraft to observe Mercury's 1.5-milion-mile-long (2.5 million kilometers) sodium tail, formed by the escape of exospheric atoms accelerated by solar radiation pressure. Perhaps the biggest surprise is how much interaction there is among the planet's interior, surface, exosphere, and magnetosphere.

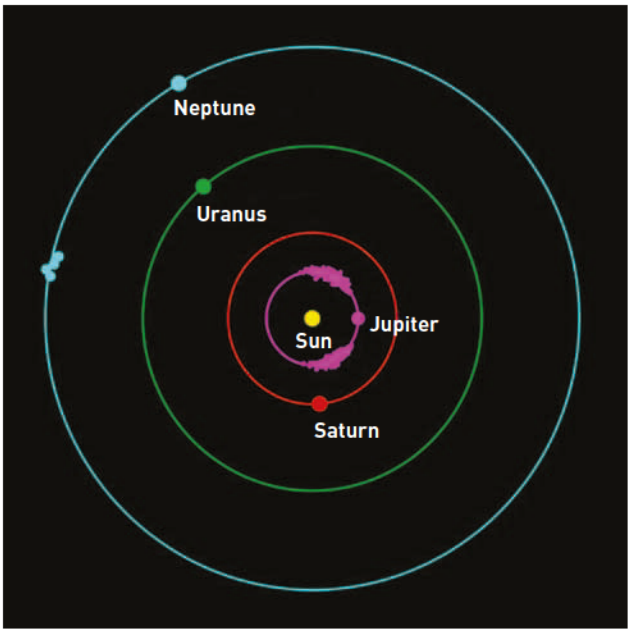
Missing Trojans: The Little Ones That Got Away

Besides the familiar planets and comets visible with a good pair of binoculars, the Solar System contains a host of small bodies that modern telescopes are revealing in increasing abundance. Trojans are asteroids that share a planet's orbit but cluster around points 60° ahead and behind the planet's path, where the pull of gravity from the planet and the Sun are in balance. The swarm of Trojans in Jupiter's orbit is the best-known group; the first was discovered in 1906. The Trojans in Neptune's orbit, being farther away from the Sun, are fainter and harder to observe. The first was not discovered until 2001, but Scott Sheppard and his colleagues believe they will turn out to be even more numerous than the Jupiter Trojans.

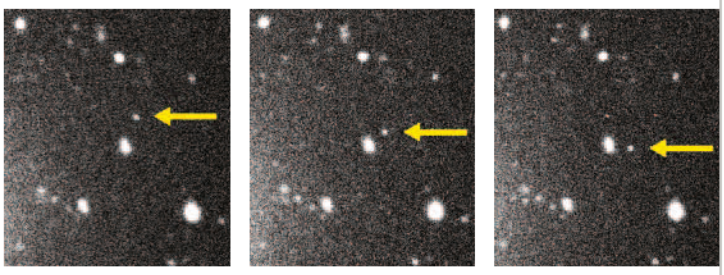
Deciphering the history of these primitive bodies can give clues to the evolution of the Solar System. Sheppard studies the coloration, orbital parameters, and size distribution of the Trojans. No Neptune Trojan is likely to have a diameter bigger than 125 miles (200 kilometers). Most are much smaller, though Sheppard has found that objects less than a few tens of miles across are relatively scarce. Jupiter Trojans and objects in the Kuiper Belt beyond Neptune's orbit show a similar pattern.

Why so few small Trojans? Sheppard hypothesizes that they were originally present, but over the Solar System's lifetime have been selectively destroyed or dispersed by collisions. Large bodies are less likely to break up during collisions because, being more massive, they have stronger gravitational fields to hold them together and attract new matter. But bodies with diameters less than about 30 miles (50 kilometers) are less likely to muster enough gravity to survive an impact, and are more likely to be scattered and lost. So, in a kind of "rich get richer, poor get poorer" dynamic, over time the large objects grow while small ones erode.

The hard-knocks life of the Neptune Trojans has broader implications, too. It can help researchers understand how primordial objects coagulated to form planetesimals—the building blocks of planets—not only in our Solar System but in those surrounding distant stars as well. □



This diagram of the Solar System shows Trojans in Jupiter's orbit (pink) clustered 60° ahead of and behind the planet. Farther out, newly discovered Neptune Trojans (blue) are also displaced 60° from the planet's position. *Image courtesy Scott Sheppard*

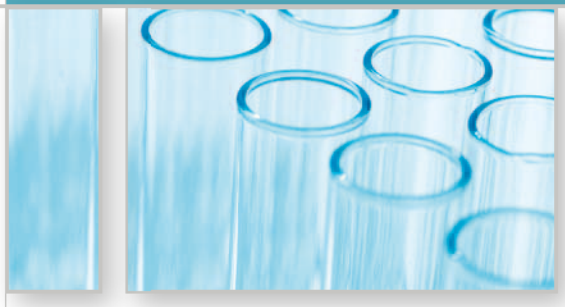


Trojans are discovered optically by their movement against a fixed background of stars. These photos of Neptune 2005 TN53 were taken over a two-hour interval with Carnegie's Magellan 6.5-meter telescope in Chile. Yellow arrows indicate the Trojan.
Image courtesy Scott Sheppard

Scott Sheppard poses at the Magellan Baade telescope at Carnegie's Las Campanas Observatory in Chile, where he scans the skies for Trojans and other small bodies in the Solar System.
Image courtesy Chad Trujillo

First Light & The Carnegie Academy

Teaching the Art of Teaching Science



First Light Turns 20!

Juna Wallace, an alumna of First Light, Carnegie's imaginative Saturday science school, returned as an intern this year—the 20th anniversary of the program. She attended First Light in the early 1990s when Julie Edmonds, codirector of the Carnegie Academy for Science Education (CASE), had just come on board as a volunteer. Like many other First Light graduates, Wallace extended the science skills nurtured by First Light; she's a Xavier University graduate who will enter medical school in the fall of 2009.

For the last three years the First Light curriculum has been based on the interdisciplinary field of astrobiology, which looks at the origins and distribution of life in the universe. Scientists at Carnegie's Broad Branch Road campus are involved in the NASA Astrobiology Institute and provide a real-world link to the students. About 20 middle schoolers participate in three six-week sessions that blend laboratory experimentation with fieldwork. In one expedition, the children learned about navigation, water analysis, and comets in an overnight session that included a boat trip on the *Half Shell* with the Living Classrooms program.

In another interdisciplinary effort, CASE is lead partner for DC Biotech: Improving Opportunities for Urban Minority Students. Partners are area schools, industry, and academic institutions. The program trains high school students for jobs in biotechnology and teaches teachers about this career path. This summer the program supported 15 interns working at Howard University, Catholic University, the J. Craig Venter Institute, the Pepper Hamilton law firm, and Carnegie headquarters. Teams of students produced four videos about work in a biotechnology laboratory. Those with communications skills learned about biology and information technology and those with a science background learned how to better communicate their research. The videos will be posted at dcbiotech.org. As another part of the effort, coordinator Marlena Jones led a biotech workplace experience at McKinley Technology High School. The 24 students were paid by the D.C. Department of Employment Services.

DC Biotech has made a big impact. This year, 39 of the 45 Biotech graduates from McKinley were accepted to college. Out of the top 10 students, seven were Biotech participants, and both the valedictorian, Obinna Ukwuani, and the salutatorian, Jennifer Guy, were graduates of the program. □

(Top left, next page) Biotechnology Workplace Program at McKinley Technology High School interns pose for a picture. From left to right, first row: Stephanie Navarrete, Keisha Blackmoore, Lanisha Dorsey, and Victor Akosile; second row: DeMarcus Clark, Kelechi Ukaegbu, Safiya Howard, and Rhia Hardman. *Image courtesy Marlena Jones*

for Science Education

(Left Center) Juna Wallace, First Light alumna from the 1990s, returned to Carnegie this year as an intern after graduating from Xavier University. She will attend medical school in 2009. *Image courtesy Toby Horn*

(Left Bottom) First Light students take their programmed robot through its paces. *Image courtesy Julie Edmonds*

(Top Right) First Light students examine macroscopic life from the Potomac River. *Image courtesy Julie Edmonds*

Financial Profile

for the year ending June 30, 2008 (unaudited)

Reader's Note: *In this section, we present summary financial information that is unaudited. Each year the Carnegie Institution, through the Audit Committee of its Board of Trustees, engages an independent auditor to express an opinion about the financial statements and the financial position of the institution. The complete audited financial statements are made available on the institution's website at www.ciw.edu.*

The Carnegie Institution of Washington completed fiscal year 2008 in sound financial condition due to the positive returns of the diversified investments within its endowment; a disciplined spending policy that balances today's needs with the long-term requirements of the institution and the interests of future scientists; and the continued support of organizations and individuals who recognize the value of nurturing basic science.

The primary source of support for the institution's activities continues to be its endowment. This reliance on institutional funding provides an important degree of independence in the research activities of the institution's scientists.

As of June 30, 2008, the endowment was valued at $870 million and had a total annual return, net of management fees, of 5.5%. Over the last five fiscal years, the endowment has grown from $526 million to more than $870 million, an increase of 65%. Carnegie's endowment has returned an annualized 14.6% over the trailing five years for the period ending June 30, 2008.

As of December 31, 2008, the date of the writing of this profile, the value of Carnegie's investments has declined by more than 20% from the June 30, 2008, valuation. This decline is consistent with the general trend in the financial markets during this period, and is also consistent with the experience of other endowments at institutions of higher education and nonprofit organizations. During this period, Carnegie has held sufficient cash and bond funds to meet all ongoing operational requirements, debt obligations, and investment obligations, thereby avoiding the need for any liquidation of equity and alternative investments at otherwise unfavorable terms. Carnegie anticipates being able to meet requirements in 2009 in a similar manner and to make financial adjustments, including limiting spending, that are necessitated by the decline in endowment value.

For a number of years, under the direction of the Finance committee of the board, Carnegie's endowment has been allocated among a broad spectrum of asset classes including: fixed-income instruments (bonds), equities (stocks), absolute return investments; real estate partnerships; private equity; and natural resources partnerships. The goal of this diversified approach is to generate attractive overall performance and minimize the volatility that would exist in a less diversified portfolio.

The Finance committee of the board regularly examines the asset allocation of the endowment and readjusts the allocation, as appropriate. The institution relies upon external managers and partnerships to conduct the investment activities, and it employs a commercial bank to maintain custody.

The following chart shows the allocation of the institution's endowment among the asset classes it uses as of June 30, 2008.

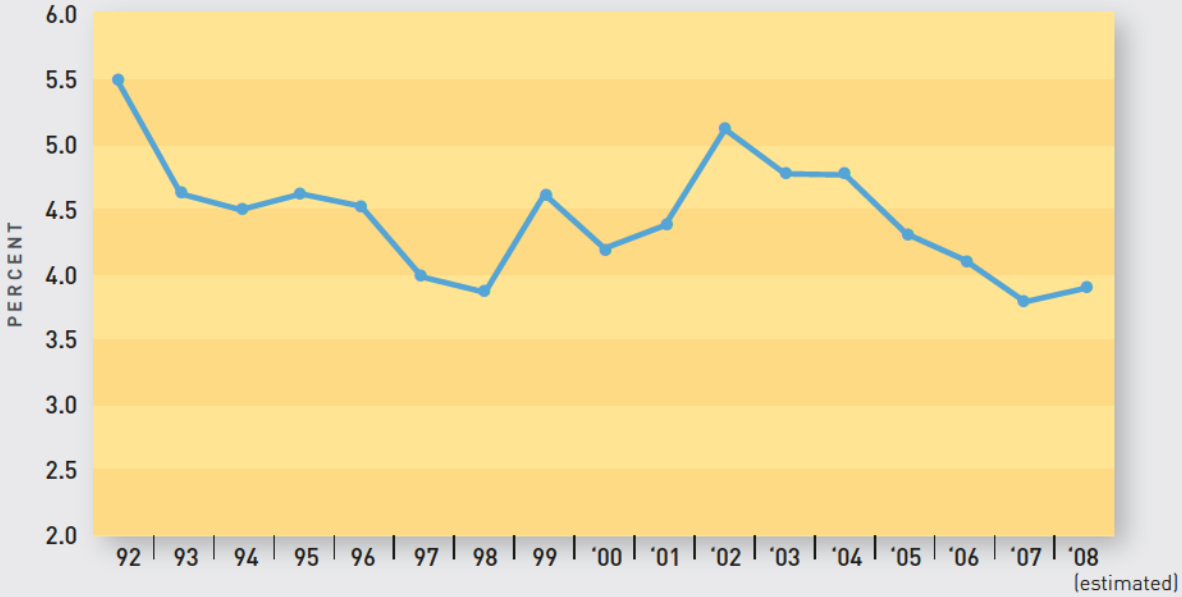
Asset Class	Target	Actual
Common Stock	35.0%	32.9%
Alternative Assets	55.0%	60.3%
Fixed Income and Cash	10.0%	6.8%

Carnegie's investment goals are to provide high levels of current support to the institution and to maintain the long-term spending power of its endowment.

Carnegie has also pursued a long-term policy of controlling its spending rate, bringing the budgeted rate down in a gradual fashion from 6+ percent in 1992 to 5.00% for 2008. Beginning with fiscal year 2008, Carnegie has revised its spending method from calculating the five percent against a simple three-year average of year-ending endowment values to a 70/30 rule, which factors in the previous year's spending. That is, the amounts available from the endowment under the 70/30 rule is made up of 70% of the previous year's budget, adjusted for inflation, and 30% of the most recently completed year-end endowment value, multiplied by the spending rate of 5.0% and adjusted for inflation and for debt. This method reduces volatility from year-to-year. The following figure depicts actual spending as a percentage of ending market value for the last 17 years.

In addition to investment performance and spending restraint, Carnegie benefits from external support. Within Carnegie's endowment, there are a number of "funds" that provide support either in a general way or targeted to a specific purpose. The largest of these is the Andrew Carnegie Fund, begun with the original gift of $10 million. Mr. Carnegie later made additional gifts totaling another $12 million during his lifetime. This tradition of generous support for Carnegie's scientific mission has continued throughout our history, and a list of donors in fiscal year 2008 appears in an earlier section of this year book. In addition, Carnegie receives important federal and private grants for specific research purposes, including support from the Howard Hughes Medical Institute for researchers at the Department of Embryology.

Endowment Spending as a Percent of Ending Value*



*Includes debt financing expenses

Statements of Financial Position (unaudited)

June 30, 2008 and 2007

	2008	2007
Assets		
Current assets:		
Cash and cash equivalents	957,861	1,896,601
Accrued investment income	138,050	265,104
Contributions receivable	6,885,460	4,928,969
Accounts receivable and other assets	6,474,614	12,685,334
Bond proceeds held by trustee	121,904	122,106
Total current assets	$ 14,577,889	$ 19,898,114
Noncurrent assets:		
Investments	895,939,989	838,384,075
Property and equipment, net	162,108,756	164,296,421
Total noncurrent assets	$1,058,048,745	$1,002,680,496
Total assets	$1,072,626,634	$1,022,578,610
Liabilities and Net Assets		
Accounts payable and accrued expenses	27,217,376	10,308,534
Deferred revenues	36,539,753	34,987,592
Bonds payable	65,303,339	65,248,695
Accrued postretirement benefits	14,486,199	14,327,973
Total liabilities	$ 143,546,667	$ 124,872,794
Net assets:		
Unrestricted	264,490,808	814,958,725
Temporarily restricted	609,844,386	27,990,125
Permanently restricted	54,744,773	54,756,966
Total net assets	$ 929,079,967	$ 897,705,816
Total liabilities and net assets	$1,072,626,634	$1,022,578,610

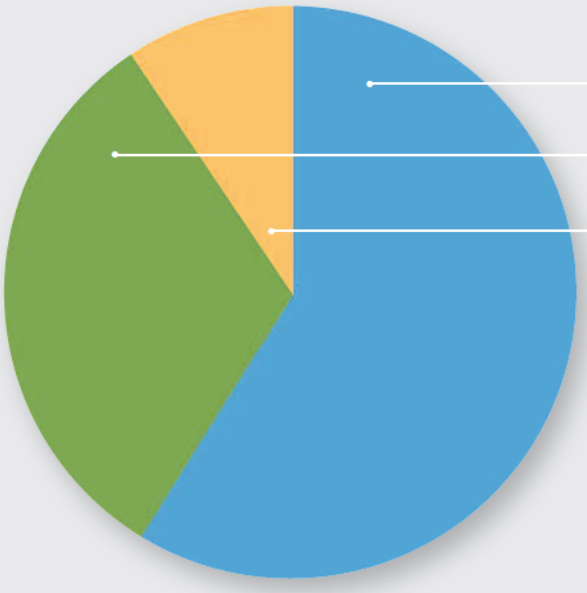
Statements of Activities[1] (unaudited)

Periods ended June 30, 2008 and 2007

	2008	2007
Revenue and support:		
Grants and contracts	$ 33,051,740	$ 31,280,089
Contributions, gifts	10,227,204	4,296,626
Net gain or (loss) on property disposal	(49,772)	(22,822)
Other income	(18,624,082)	7,075,827
Net external revenue	$ 24,605,090	$ 42,629,720
Investment income, net	81,245,420	140,942,874
Total revenues, gains, other support	$105,850,510	$183,572,594
Program and supporting services:		
Terrestrial Magnetism	11,635,917	11,083,178
Observatories	18,455,315	17,816,485
Geophysical Laboratory	14,125,190	13,096,369
Embryology	8,593,858	8,635,996
Plant Biology	10,518,171	9,928,992
Global Ecology	4,263,800	3,936,862
Other programs	661,776	609,667
Administration and general expenses	6,853,537	7,967,307
Total expenses	$ 75,107,564	$ 73,074,856
Adoption of FASB Statement No. 158	—	(771,001)
Pension Related Changes	631	—
Increase (decrease) in net assets	31,374,151	109,736,737
Net assets at the beginning of the period	897,705,816	787,979,079
Net assets at the end of the period	$929,079,967	$897,705,816

[1]Includes restricted, temporarily restricted, and permanently restricted revenues, gains, and other support.

2008 Revenues and Gains ($106 million)

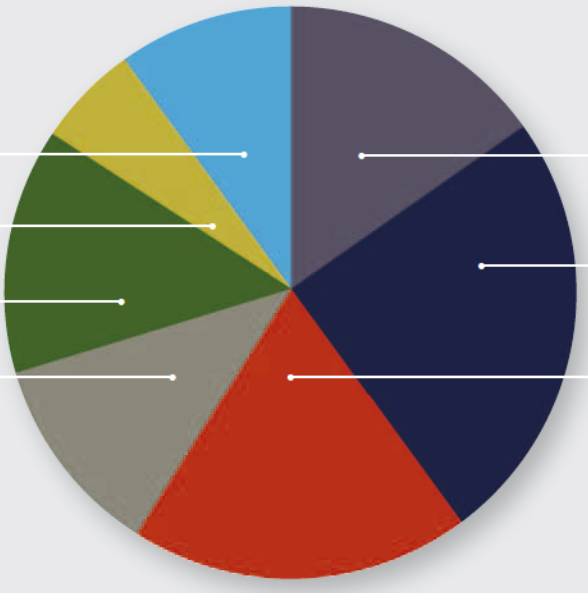


59.1% Investment and Other Income

31.2% Grants and Contracts

9.7% Gifts and Other Contributions

2008 Expenses by Department ($75.1 million)



Administration/Other **10.0%**

Global Ecology **5.7%**

Plant Biology **14.0%**

Embryology **11.4%**

15.5% Terrestrial Magnetism

24.6% Observatories

18.8% Geophysical Laboratory

Personnel

July 1, 2007-June 30, 2008

Carnegie Administration

Benjamin Barbin, *Manager of Advancement Activities*
Sharon Bassin, *Assistant to the President/Assistant Secretary to the Board*
Shaun Beavan, *Systems Administrator*
Gloria R. Brienza, *Budget and Management Analysis Manager*
Don Brooks, *Building Maintenance Specialist*
Marjorie Burger, *Financial Manager*
Cady Canapp, *Human Resources and Insurance Manager*
Alan Cutler, *Science Writer*[1]
Stephanie DeVos, *Advancement Intern*[2]
Robert Ellis, *Web Developer*[3]
Shawn Frazier, *Accounting Technician*[4]
Dina Freydin, *Senior Grants Accountant*
Susanne Garvey, *Director of External Affairs*
Jason Gebhardt, *Research Assistant for Advancement*
Patricia Harrigan, *Financial Accountant*[5]
Darla Keefer, *Special Assistant for Administration and Building Operations*
Caitlyn Kennedy, *Advancement Intern*[6]
Mulyono Kertajaya, *Business Data Analyst/Developer*[7]
Ann Keyes, *Payroll Coordinator*
Yang Kim, *Deputy Financial Manager*
Lisa Klow, *Secretary to the President*
George Gary Kowalczyk, *Director of Administration and Finance*
Tina McDowell, *Editor and Publications Officer*
Richard Meserve, *President*
June Napoco-Soriente, *Financial Accountant*
Mikhail Pimenov, *Endowment Manager*
Arnold J. Pryor, *Facilities Coordinator*
Gotthard Sághi-Szabó, *Chief Information Officer*
Vinutha Saunshimath, *Computer Systems Associate*[8]
Ashit Sheth, *Computer Systems Associate*[9]
Harminder Singh, *Financial Systems Accountant*[10]
Christine Smith, *Chief Advancement Officer*[11]
John Strom, *Web Manager*
Mira Thompson, *Manager of Advancement Operations*
Kenneth Tossell, *Computer Systems Associate*
Vickie Lee Tucker, *Administrative Coordinator*[12]
Yulonda White, *Human Resources and Insurance Records Coordinator*
Jacqueline Williams, *Assistant to Human Resources and Insurance Manager*
Matthew Wright, *Science Writer*[13]

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[1] From October 1, 2007
[2] To August 23, 2007
[3] From January 22, 2008
[4] From October 1, 2007
[5] To October 9, 2007
[6] From May 27, 2007
[7] From March 24, 2008
[8] From March 2, 2008
[9] From May 14, 2008
[10] From November 5, 2007
[11] To May 23, 2008
[12] To September 7, 2007
[13] To August 8, 2008

Carnegie Academy for Science Education

Brenton Bassin, *Intern*[1]
Sarah Bax, *Mentor Teacher*[1,2]
Guy Brandenburg, *First Light Instructor, Mentor Teacher*[1,2]
John Buchanan, *Mentor Teacher*[2]
Derek Butts, *First Light Assistant*[3]
Shaina Byrnes, *Summer Forensics Instructor,*[2] *CASE Coordinator*[4]
Alexander Cole, *Intern*[1,2]
Asonja Dorsey, *Mentor Teacher*[1,2]
Nia Doweary, *Intern*[2]
VanNessa Duckett, *Mentor Teacher*[1,2]
Audrey Edmonds, *CASE Coordinator,*[5] *Intern*[2]
Julie Edmonds, *Codirector*
Jessica Franklin, *Mentor Teacher*[2]
Ricky Garibay, *First Light Assistant, Intern*[1,2]
Joseph Geglia, *Intern*[2]
Tashima Hawkins, *Mentor Teacher*[1,2]
Anne Hemphill, *Mentor Teacher*[1,2]
Gayan Hettipola, *Intern*[1,2]
Toby Horn, *Codirector*
Marlena Jones, *DC Biotech Coordinator*[6]
Loretta Kelly, *Mentor Teacher*[1,2]
Yeelan Ku, *DC Biotech Assistant*[7]
Becky Lippy, *Intern*[2]
Robert Lucas, *Intern*[2]
Fran McCrackin, *Mentor Teacher*[2]
Thomas Nassif, *Mentor Teacher*[1,2]
Maxine Singer, *Senior Scientific Advisor*
Henry Spencer, *Intern*[1]
John Tatum, *Mentor Teacher*[1]
Annie Thompson, *Mentor Teacher*[2]
Juna Wallace, *First Light Assistant*[7], *DC Biotech Assistant*[7]

DC Biotech Summer Teacher Fellows

Joseph Isaac[2]
Monique Petersen[2]

DC Biotech Interns

Victor Akosile[1,2]
Monica Artis[1,2]
Vanessa Banks[2]
Keisha Blackmoore[1]
DeMarcus Clark[1,2]
Ngonda Dibango[2]
Lanisha Dorsey[1]
Joseph Green[1]
Rhia Hardman[1,2]
Nolan Harris[2]
Safiya Howard[1]
Cassie Lewis[2]
Elishauntae` Lindsay[1]
Kaya Lowery[1]
Michael McCreary[1]
Stephanie Navarrete[1]
Tuan Nguyen[2]
Marciel Rojas-Rosario[1]
Jimmika Smallwood[2]
Kelechi Ukaegbu[1]
Obinna Ukwuani[2]
Isaiah West[1]

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[1] Summer 2008
[2] Summer 2007
[3] To May 30, 2007
[4] August 1 to November 30, 2007
[5] From January 30 to June 15, 2007
[6] From December 1, 2007
[7] From October 1, 2007

Embryology

Research Staff Members

Alexsky Bortvin
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Yixian Zheng

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Julie Gleason, *Carnegie Fellow* [7]
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James Walters, *American Cancer Society Fellow*
Shusheng Wang, *Research Associate, NIH Grant (Zheng)*
Zheng-an Wu, *Special Investigator, NIH Grant (Gall) and Carnegie Fellow*
Cheng Xu, *NIH Grant (Fan) and Carnegie Fellow*

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Juliana Carten, *The Johns Hopkins University* [13]
Julio Castaneda, *The Johns Hopkins University*
Daniel Ducat, *The Johns Hopkins University*
Ben Goodman, *The Johns Hopkins University*
Robyn Goodman, *The Johns Hopkins University* [14]
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Margaret Hoang, *The Johns Hopkins University*
Christoph Lepper, *The Johns Hopkins University*
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Daniel Lighthouse, *The Johns Hopkins University*
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Lori Orosco, *The Johns Hopkins University*
Andrew Skora, *The Johns Hopkins University*
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Elçin Ünal, *The Johns Hopkins University* [19]
Lamia Wahba, *The Johns Hopkins University*
Aaron Welch, *The Johns Hopkins University* [20]

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Colin Huck, *Animal Technician* [36]
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Alison Singer, *Research Technician* [45]
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Ina Soh, *Research Undergraduate* [47]
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Xin Wang, *P/T Laboratory Helper* [51]
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[1] To August 21, 2007
[2] To August 9, 2007
[3] To July 31, 2007
[4] From April 7, 2008
[5] From September 17, 2007
[6] To August 13, 2007
[7] From February 11, 2008
[8] From January 2, 2008
[9] To August 17, 2007
[10] To September 30, 2007
[11] To September 30, 2007
[12] To February 8, 2008
[13] From June 2, 2008
[14] To July 4, 2007
[15] From June 2, 2008
[16] From January 21, 2007
[17] From June 2, 2008
[18] To December 31, 2007
[19] To December 31, 2007
[20] From June 2, 2008
[21] From August 31, 2007
[22] From September 20, 2007
[23] To July 13, 2007
[24] From October 5, 2007
[25] From June 2, 2008
[26] From May 17, 2007 (omitted from previous year book)
[27] From June 16, 2008
[28] From September 6, 2007
[29] From June 16, 2008
[30] To January 31, 2008
[31] To October 27, 2007
[32] To December 31, 2007
[33] To June 13, 2008
[34] From May 19, 2008
[35] From September 17, 2007
[36] From February 23, 2008
[37] To January 31, 2008
[38] From September 17, 2007
[39] From September 17, 2007
[40] From June 16, 2008
[41] To July 5, 2007
[42] From May 19, 2008
[43] From February 19, 2008
[44] From June 11, 2008
[45] From August 10, 2007
[46] To September 14, 2007
[47] From January 2, 2008
[48] From September 17, 2007
[49] From September 24, 2007
[50] To August 17, 2007
[51] To August 21, 2007

Geophysical Laboratory

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George D. Cody
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Jinfu Shu, *Research Technician, HPCAT*
Stanislav Sinogeikin, *Beamline Scientist, HPCAT*
Lin Wang, *Balzan Fellow, Postdoctoral Researcher, HPCAT and HPSynC*
Yuming Xiao, *Postdoctoral Research Associate, HPCAT*[15]
Wenge Yang, *Beamline Scientist, HPCAT*
Qiaoshi Charles Zeng, *Predoctoral Research Associate, HPSynC*[16]

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Pierre Beck, *Carnegie Fellow*[17]
Andrey Bekker, *Carnegie Fellow, NAI*[18]
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Timothy Jenkins, *Postdoctoral Associate, DOE*[22]
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Svetlana Kharlamova, *Postdoctoral Associate*[24]
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Takahiro Kuribayashi, *JSPS Fellow, Japan*
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Konstantin Litasov, *Postdoctoral Associate, NSF*[27]
Xuan Luo, *Postdoctoral Associate, NSF*[28]
Yufei Meng, *Postdoctoral Associate*
Javier Antonio Montoya Martinez, *Carnegie Fellow*[29]
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Ravindran Thoguluva, *Postdoctoral Associate, DOE*[36]
Hikaru Yabuta, *Carnegie Fellow*[37]
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Lin Wang, *Postdoctoral Associate, Balzan Foundation Fund*[38]
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Verena Starke, *NASA Marshall Space Flight Center*
Hong Yang, *NSF*[43]
Shidan Yu, *Predoctoral Research Associate*[44]
Yong Yu, *Predoctoral Research Associate*[45]

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Emily Snyder, *American University, DTM NAI funding*
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Emily Heying, *Wartburg College*
Emme Johnston, *Mount Holyoke College*
Rohan Kundargi, *University of California, Los Angeles*
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Greg Pelkey, *College of Charleston*
Erin Wirth, *New York University*

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Thomas Gramsch, *Lake Braddock High School*
Maura James, *Convent of the Sacred Heart*
Andrew Kung, *Montgomery Blair High School, Balzan Fellow*
Maneeshika Madduri, *Thomas Jefferson High School for Science and Technology*
Jackie Rivera, *Cesar Chavez High School*
Benjamin Shih, *Montgomery Blair High School*

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Shaun J. Hardy, *Librarian*[55]
Stephen Hodge, *Instrument Maker*
Garret Huntress, *Systems Administrator, Systems Developer*
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Eugene Zhao, *Electronics Engineer*[62]

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Sven Bilke, *NCI*
Robert Botto, *ACS PRF*

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Kevin Driver, *Ohio State University*
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Loise Gaillou, *Smithsonian Institution*
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Christopher Jonsson, *The Johns Hopkins University*
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Srinivas Kulkarni, *Florida International University*
Takahiro Kuribayashi, *Tokyo Institute of Technology*
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Peter Lazor, *Uppsala University, Sweden*
Jie Li, *University of Illinois–Urbana-Champaign*
Yu Lin, *Stanford University*
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Jing Liu, *Chinese Academy of Sciences*
Zhiguo Liu, *Harbin Institute of Technology, China*
Matthew S. Lucas, *California Institute of Technology*
Wendy Mao, *Stanford University*
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Kelton McMahon, *Woods Hole Oceanographic Institution*
Kristen Miller, *University of Maryland*
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Natalie Monacci, *University of Alaska Fairbanks*
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Nishad Phatak, *Florida International University*
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Steve Richardson, *University of Cape Town*
Gillian Robbins, *Rutgers University*
Anat Shahar, *UCLA*
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Liling Sun, *Institute of Sciences, Beijing*
Lingyun Tang, *Chinese Academy of Sciences*
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David Wacey, *Oxford University*
Andrew Walters, *University College London*
Luhong Wang, *HPCAT*
Shibing Wang, *Stanford University*
Gwyn Williams, *Thomas Jefferson National Accelerator Facility*
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Jian Xu, *Institute of Fluid Physics, Chinese Academy of Engineering Physics*
Hexiang Yang, *University of Arizona*
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Yong Yu, *Institute of Sciences, Beijing*
Qiaoshi Zeng, *Zhejiong University, China*

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[1] From July 1, 2007
[2] To October 12, 2007
[3] From April 1, 2008
[4] To November 3, 2007
[5] To April 30, 2008
[6] From September 1, 2007
[7] From August 1, 2007
[8] From August 27, 2007
[9] From July 1, 2007
[10] To September 1, 2007
[11] To December 7, 2007
[12] From March 1, 2008
[13] From August 1, 2007, to July 31, 2008
[14] From September 1, 2007
[15] From September 9, 2007
[16] From September 1, 2007
[17] To August 1, 2007
[18] To August 31, 2007
[19] From August 1, 2007
[20] From September 1, 2007
[21] From November 1, 2007
[22] To July 6, 2007
[23] From September 4, 2007
[24] From May 1, 2008
[25] From January 9, 2008
[26] From September 1, 2007
[27] From October 1, 2007
[28] From August 1, 2007
[29] From January 1, 2008
[30] From February 1, 2008
[31] To May 31, 2008
[32] To February 20, 2008
[33] To July 27, 2007
[34] From September 4, 2007
[35] To February 3, 2008
[36] From December 3, 2007
[37] To April 28, 2008
[38] From January 1, 2007
[39] From March 5, 2007
[40] From January 9, 2007
[41] To August 30, 2007
[42] From March 16, 2007
[43] From February 15, 2008
[44] From January 1, 2008
[45] From March 1, 2008
[46] From June 2, 2008
[47] From June 23, 2008
[48] From October 1, 2007, to March 1, 2008
[49] From November 27, 2007
[50] Joint appointment with DTM
[51] Joint appointment with DTM
[52] Joint appointment with DTM
[53] Joint appointment with DTM
[54] Retired on May 1, 2008
[55] Joint appointment with DTM
[56] Retired on December 3, 2007
[57] Joint appointment with DTM
[58] Joint appointment with DTM
[59] Joint appointment with DTM
[60] From May 11, 2007, to October 31, 2007
[61] Joint appointment with DTM
[62] From February 20, 2008
[63] From September 17, 2007

GLOBAL ECOLOGY First row (left to right): Robin Martin, Turkan Eke, Jan Brown, Linda Longoria, Kyla Dahlin, Kirkill Caldeira, Ken Caldeira, Adam Wolf, Kim Nicholas-Cahill, Paul Sterbentz. Second row: Mona Houcheime, Naoia Williams, Kathi Bump, Claire Lunch, David Knapp, Evana Lee, Marion O'Leary, Alex Nees, Chris Field, Steve Davis. Third row: James Jacobson, Melinda Belisle, Ruth Emerson, Yuka Estrada, KT Mertes, Jennifer Johnson, Todd Tobeck. Fourth row: Long Cao, Parker Weiss, Matt Colgan, Chris Doughty, Jack Silverman, George Ban-Weiss, Joe Berry, Greg Asner, Shaun Levick, Ty Kennedy-Bowdoin, Christian Andreassi, Roland Pieruschka.

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Joseph A. Berry
Kenneth Caldeira
Christopher B. Field, *Director*

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James Kellner, *University of Georgia*[2]
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Mitsuhiko Tsukimoto, *Laboratory Technician*[13]
Tim Varga, *Laboratory Technician*[14]

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[1] To March 15, 2008
[2] From June 2, 2008
[3] From May 19, 2008
[4] To April 1, 2008
[5] From September 24, 2007
[6] From April 16, 2007, to September 30, 2007
[7] From April 16, 2007, to September 30, 2007
[8] From January 22, 2008
[9] From February 19, 2008
[10] To August 31, 2007
[11] To March 31, 2008
[12] From January 9, 2008
[13] To August 31, 2007
[14] To May 31, 2008

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[1]To October 31, 2007
[2]To July 31, 2007
[3]To July 2, 2007
[4]To August 31, 2007
[5]From October 1, 2007, formerly Carnegie Fellow
[6]From September 15, 2007
[7]From July 20, 2007
[8]From August 1, 2007
[9]From June 1, 2008
[10]From November 1, 2007
[11]From January 1, 2008, formerly Collison
[12]From April 16, 2008, formerly Magellan Project Admin. Asst./Asst. Business Manager
[13]From February 6, 2008
[14]To August 19, 2007
[15]From December 10, 2007
[16]To April 16, 2008
[17]From January 9, 2008
[18]From January 2, 2008
[19]To February 12, 2008
[20]From February 26, 2008
[21]To August 29, 2007
[22]To August 27, 2007
[23]From August 28, 2007
[24]To April 13, 2008

Plant Biology

July 1, 2007 – June 30, 2008

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Ryan Gutierrez, *Stanford University*
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Katherine Mackey, *Stanford University*
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Peifen Zhang, *Curator*

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[1] Acting director from December 1, 2007
[2] Leave of absence from November 30, 2007
[3] Leave of absence from January 1, 2008
[4] To December 31, 2007
[5] From January 18, 2008
[6] To February 29, 2008
[7] From February 1, 2008, to May 31, 2008
[8] From September 13, 2007
[9] To October 1, 2007
[10] To November 1, 2007
[11] To September 22, 2007
[12] To April 13, 2008
[13] From October 15, 2007
[14] To April 30, 2008
[15] From May 1, 2008
[16] From November 16, 2007, to April 30, 2008
[17] To June 8, 2008
[18] To December 14, 2007
[19] To August 24, 2007
[20] From October 1, 2007
[21] To March 16, 2008
[22] To March 28, 2008
[23] To July 31, 2007
[24] From September 5, 2007
[25] To May 31, 2008
[26] To August 31, 2007
[27] From February 22, 2008
[28] From September 1, 2007
[29] From September 1, 2007, to March 16, 2008
[30] To March 31, 2008
[31] To January 7, 2008
[32] From February 1, 2008
[33] To September 28, 2007
[34] From August 15, 2007, to March 19, 2008
[35] From July 1, 2007
[36] To May 22, 2008
[37] To April 1, 2008
[38] To October 31, 2007
[39] From March 17, 2008
[40] From March 3, 2008
[41] From April 29, 2008
[42] To June 30, 2008
[43] From April 17, 2008
[44] To February 8, 2008
[45] From September 1, 2007
[46] From April 14, 2008
[47] From March 16, 2008
[48] To August 22, 2007
[49] From January 7, 2008
[50] From November 1, 2007
[51] From November 12, 2007, to February 15, 2008
[52] From July 9, 2007, to October 18, 2007
[53] From August 27, 2007
[54] From October 11, 2007

Terrestrial Magnetism

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[1]From July 1, 2007
[2]From May 1, 2008
[3]To May 16, 2008
[4]To July 27, 2008
[5]From October 1, 2007
[6]To September 1, 2007
[7]From September 1, 2007
[8]To December 15, 2007
[9]From October 12, 2007
[10]To October 31, 2007
[11]From January 7, 2008
[12]To August 9, 2007
[13]From September 19, 2007
[14]Joint appointment with Geophysical Laboratory
[15]To April 18, 2008
[16]Deceased April 12, 2008

Bibliography

July 1, 2007 - June 30, 2008

EMBRYOLOGY

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A bequest is both a tangible demonstration of your dedication to the Carnegie Institution and a way to generate significant tax savings for your estate. Some bequests to Carnegie have been directed to fellowships, chairs, and departmental research projects. Some have been additions to the endowment, other bequests have been unrestricted.

The following sample language can be used in making a bequest to the Carnegie Institution:

"I give and bequeath the sum of $_____(or % of my residuary estate) to the Carnegie Institution of Washington, 1530 P Street, N.W., Washington, DC 20005-1910."

For additional information:

SEE THE CARNEGIE WEB SITE
http://www.ciw.edu/support

OR CALL
The Office of Advancement
202.387.6400

OR WRITE
The Office of Advancement
Carnegie Institution of Washington
1530 P Street, N.W.
Washington, DC 20005-1910